MEMOIRS

OF THE

MUSEUM OF COMPARATIVE ZOÖLOGY

AT

HARVARD COLLEGE.

VOL. XLIX.

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PRINTED BY
The Cosmos Press, Incorporated
Cambridge, Mass.

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XXXIX.

REPORTS ON THE SCIENTIFIC RESULTS OF THE EXPEDITION TO THE EASTERN TROPICAL PACIFIC, IN CHARGE OF ALEXANDER AGASSIZ, BY THE U. S. FISH COMMISSION STEAMER "ALBATROSS," FROM OCTOBER, 1904, TO MARCH, 1905, LIEUT.-COMMANDER L. M. GARRETT, U. S. N., COMMANDING.

XXXIV.

THE PELAGIC NEMERTEANS.

By WESLEY R. COE.

WITH THIRTY PLATES.

[Published by permission of Henry O'Malley, U. S. Fish Commissioner].

CAMBRIDGE, U. S. A.
Printed for the Museum.
June, 1926.

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REPORTS on an exploration off the west coasts of Mexico, Central and South America, and off the Galapagos Islands, in charge of ALEXANDER AGASSIZ, by the U. S. Fish Commission Steamer "Albatross" during 1891, Lieut.-Commander Z. L. TANNER, U. S. N., commanding. XXXIX. Reports on the scientific results of the expedition to the Eastern Tropical Pacific, in charge of ALEXANDER AGASSIZ, by the U. S. Fish Commission Steamer "Albatross," from October, 1904, to March, 1905, Lieut.-Commander L. M. GARRETT, U. S. N., commanding. XXXIV. The Pelagic Nemerteans. By WESLEY R. COE. 246 pp. 30 plates. June, 1926.

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INTRODUCTION.

THE collections of the U. S. F. C. S. ALBATROSS on which this report is based were made on the following expeditions:—

1. A cruise to the equatorial region of the Pacific Ocean off the west coast of America and about the Galapagos Islands in 1891 under the direction of Mr. Alexander Agassiz. On this voyage five specimens of *Planktonemertes agassizii* were obtained. These were described by Dr. W. McM. Woodworth (1899), and proved of much scientific interest inasmuch as this was the third pelagic genus to be discovered, only the genera Pelagonemertes and Nectonemertes having previously been described. On the same expedition a single specimen of a form closely resembling Planktonemertes was taken, and this on sectioning proved to belong to a new genus and species. It is described in this report under the name *Planonemertes lobata*.

2. On the cruise of the ALBATROSS in the Eastern Tropical Pacific, October, 1904, to April, 1905 six species of pelagic nemerteans were secured, all but one of which, *Nectonemertes pelagica*, represented hitherto undescribed species, three of them belonging to new genera. These new forms are *Dinonemertes mollis*, sp. nov., *Neuronemertes aurantiaca*, gen. et sp. nov., *Plionemertes plana*, gen. et sp. nov., *Cuneonemertes gracilis*, gen. et sp. nov., and *Pelagonemertes joubini*, sp. nov. Each of these has been carefully studied by means of serial sections and is fully described in this report.

3. The Northwest Pacific expedition, May to December, 1906, made collections off the coast of Alaska and thence to Japan and the Japan Sea. This expedition secured three species of these bathypelagic worms, namely, *Nectonemertes pelagica*, *Proarmaueria pellucida*, gen. et sp. nov., and *Pelagonemertes brinkmanni*, sp. nov., the last being represented by twenty-three specimens.

Although these collections are small as compared with those of several of the European expeditions mentioned (p. 11–16), yet the five new genera and eight new species which they contain present a sufficiently novel combination of characters to add considerably to previous knowledge of this group of animals.

The preparation of this report was begun some years before the appearance of Brinkmann's monograph on the pelagic nemerteans ('17a), but the material has been revised and incorporated in so far as possible into his system of classification. For convenience of comparison figures of the previously described forms have been included in the text.

Some of the specimens were first entrusted to the late W. McM. Woodworth, who published a preliminary report (1899) on *Planktonemertes agassizii* and prepared serial sections of this species. Shortly before Dr. Woodworth's death, all the specimens, microscopic preparations, drawings and notes were turned over to the present writer for further study and for the preparation of the report which has been so long delayed.

In the meantime there has been a great advance in the knowledge of the pelagic life of the oceans, thanks to the discoveries made by a number of expeditions sent out for this purpose. In addition to the other groups of pelagic organisms, the nemerteans were found to be a widely distributed group, and are now known from all the oceans except the Antarctic.

The number of these more recently described forms is thus in marked contrast with the few species previously known; that is, those described twenty or more years ago. Previous to the year 1900, the pelagic nemerteans were considered among the rarest of organisms, for up to that time only thirteen specimens, belonging to four species, had been studied. These were *Pelagonemertes rollestoni* Moseley and *Pelagonemertes moseleyi* Bürger, with one specimen each from the CHALLENGER explorations, *Nectonemertes mirabilis* Verrill (including *Hyalonemertes atlantica* Verrill), with six specimens and *Planktonemertes agassizii* Woodworth, with five specimens.

The more recent collections include not only additional genera and species but additional specimens of three of the four species described earlier. They also greatly extend the known geographical range of these species.

The announcement of the first discovery of a truly pelagic nemertean was the account of *Pelagonemertes rollestoni* by Moseley (1875). This was shortly followed by a description and excellent figure of another specimen published by Moseley (1875a) in the same year. Moseley's first specimen came from far south of Australia, while his second specimen, which he supposed to be the young of the same species, was collected off the coast of Japan. This latter specimen was lost in an attempt to preserve it. Bürger (1895), however, clearly recognized its specific distinction and gave it the name *P. moseleyi*.

Moseley's first specimen was later made the subject of a detailed study by Hubrecht (1887), who fully described the various organ-systems from a study of serial sections. This specimen was a female; the male remaining unknown until described by Bürger ('09).

The next discovery of a pelagic nemertean was announced by Verrill (1892) who gave detailed and accurate descriptions of the external anatomy of two supposed forms. One of these was characterized by the presence of a pair of lateral appendages, which Verrill termed cirri, on the lateral borders of the body immediately behind the head. This form he named *Nectonemertes mirabilis.* The other form was similar to the first in its general organization, but was without the cirri, or tentacles as they are now usually called. Verrill considered this distinction sufficient for the establishment of a separate genus, and he named it Hyalonemertes, the species being *H. atlantica.* Both Verrill and Bürger recognized the close similarity of the two forms, but it remained for Brinkmann ('12) to call attention to the fact that they were in reality only the two sexes of a dimorphic species, the males having the tentacles when sexually mature, but the females were without them. The valid name of the species is *Nectonemertes mirabilis,* for this name occurs in Verrill's paper (1892). The species has recently been fully studied by means of serial sections and its anatomical features described in much detail by Brinkmann ('17a) and by Coe and Ball ('20).

Next came the discovery of *Planktonemertes agassizii,* a form in which both mouth and proboscis have a common opening. This was taken in the tropical Pacific and was described by Woodworth (1899) from a superficial study of cleared specimens. The internal anatomy as shown by serial sections of several specimens is described in detail in the present report.

From the coast of California, Cravens and Heath ('06) have described in great detail the males of a species of Nectonemertes (*N. pelagica*), including a most complete study of the histological structure of each of the organ-systems of the body.

The males of still another species of the same genus, *Nectonemertes japonica,* have been briefly described by Miss Foshay ('12) from the coast of Japan. This also differs from other species by the arrangement of the spermaries.

Collections of pelagic nemerteans were also made on various expeditions under the auspices of the Prince of Monaco (1898-1905), the sumptuous reports of which are of great service to students of marine biology. In preliminary reports, Joubin ('04 and '06) gives superficial descriptions of ten supposedly new species of pelagic nemerteans from the middle Atlantic Ocean, the region of the Sargasso Sea, and eastward to the vicinity of the Azores and Madeira.

Most of these species were represented by single specimens and were studied only as entire objects, before and after clearing. For a reliable identification of either genus or species in the pelagic nemerteans, however, serial sections are usually necessary, and until these are made and described both the generic and specific identity of every one of Joubin's forms will be more or less doubtful. Only by their sacrifice to the microtome can such specimens of nemerteans be of real service to science.

The list of these species, with their provisional assignment is as follows:—

1. *Pelaganemertes richardi* Joubin = *Gelanemertes richardi* Coe.
2. *Nectonemertes grimaldii* Joubin = *N. mirabilis* Verrill.
3. *Nectonemertes chavesi* Joubin = *Balaenanemertes chavesi* Brinkmann.
4. *Nectonemertes lobata* Joubin = *Balaenanemertes lobata* Brinkmann.
5. *Planktonemertes grimaldii* Joubin = *Dinonemertes grimaldii* Brinkmann.
6. *Planktonemertes alberti* Joubin = *Dinonemertes alberti* Brinkmann.
7. *Planktonemertes zonata* Joubin = (?) *Parabalaenanemertes zanata* (Joubin).
8. *Planktonemertes sargassicola* Joubin = *Mononemertes sargassicola* Coe.
9. *Planktonemertes elongata* Joubin = (?) *Chuniella elongata* (Joubin).
10. *Planktonemertes rhomboidalis* Joubin = (?) *Crassonemertes rhamboidalis* (Joubin).

On the German South Polar expedition of 1901–1903, nine specimens of pelagic nemerteans were collected in the Atlantic Ocean. These were studied by Brinkmann and described in a preliminary paper in the Bergens Museums Aarbok ('15–'16). The final report (Brinkmann '18) gives a more complete anatomical description and numerous illustrations of the following species:—

1. *Planktonemertes vanhöffeni* Brinkmann, a new species from west of the Cape of Good Hope.
2. *Paradinonemertes drygalskii* Brinkmann, a new genus characterized by having the mouth situated behind the brain, but resembling Dinonemertes in most other particulars.
3. *Nectonemertes minima* Brinkmann, a new specific name for the species erroneously identified by Bürger as *Hyalonemertes atlantica* (= *N. mirabilis* Verrill).
4. *Pelagonemertes rollestoni* Moseley, from west of the Cape of Good Hope.

One of the most important expeditions so far as the pelagic nemerteans are concerned was the German Tiefsee expedition of the steamer VALDIVIA during 1898 and 1899. These collections were made in the Atlantic off the west coast of Africa and throughout a large part of the Indian Ocean. The nemerteans were studied in some detail by Dr. Otto Bürger, whose report ('09) describes and beautifully illustrates seven supposed species, of which three were thought to be new to science. The new forms include a new and remarkable genus, Balaenanemertes.

Bürger's identification of his material proves, in the light of more recent discoveries, to have been erroneous in some cases, due largely to the incompleteness of the specific descriptions which had been published up to that time and on which he then had to rely. Brinkmann ('15, '17, '17a) has already called attention to these errors and has proposed new names in place of those incorrectly used by Bürger.

A list of these forms, with the species to which it now appears that they should be assigned, is as follows:—

1. *Pelagonemertes rollestoni* Moseley.
2. *Planktonemertes agassizii* Bürger = *Chuniella agassizii* Brinkmann. (*non Planktonemertes agassizii* Woodworth).
3. *Planktonemertes woodworthii* Bürger = *Mergonemertes woodworthii* Brinkmann.
4. *Balaenanemertes chuni* Bürger.
5. *Nectonemertes mirabilis* Bürger = *N. primitiva* Brinkmann. (*non N. mirabilis* Verrill).
6. *Hyalonemertes atlantica* Bürger = *Nectonemertes minima* Brinkmann. (*non Hyalonemertes atlantica* = *Nectonemertes mirabilis* Verrill).
7. *Drepanophorus pelagicus* Bürger = *Chuniella pelagica* Brinkmann.

The reasons for making the generic and specific assignments indicated are given in the present report in the general discussion of each of the species concerned.

Laidlaw ('06) describes two new genera of deep sea nemerteans from the Indian Ocean. One of these, *Dinonemertes investigatoris*, is a bathypelagic form, and is distinguished from Planktonemertes by having separate openings for the mouth and rhynchodeum.

Brinkmann ('12) describes a very remarkable new genus and species, *Phallonemertes* (*Bathynectes*) *murrayi*, the males of which are peculiar in having finger-like genital papillae projecting from the sides of the body just back of the head. One of the specimens of this species was collected on the INGOLF expedition in 1895 and others by the Norwegian steamer MICHAEL SARS in 1910.

Up to the present time the most successful expedition in so far as the collection of pelagic nemerteans is concerned is the MICHAEL SARS North Atlantic deep sea expedition of 1910. This was carried out under the auspices of the Norwegian government and the superintendence of Sir John Murray and Dr. Johan Hjort. (See p. 89.) For the first time in the history of pelagic explorations the organisms inhabiting the different layers of water as determined by salinity and temperature could be charted with much accuracy, and thus made possible a reasonable explanation of their geographical distribution.

The pelagic nemerteans collected by this expedition were very thoroughly studied by Dr. August Brinkmann and an illustrated description of the new and little known species was published in volume 3, Zoölogy, of the scientific results of the expedition (Brinkmann, '17).

The collection contained ten new species, referred to eight new genera, in addition to six species which had been previously described.

The study of these has added many new and important anatomical features to those already known in pelagic nemerteans. These will be referred to in the systematic account of species, and in the anatomical summary.

The list of species is as follows: —

1. *Bathynemertes hubrechti* Brinkmann (= *Protopelagonemertes hubrechti* Brinkmann, '17a).
2. *Plotonemertes adhaerens* Brinkmann.
3. *Pendonemertes levinseni* Brinkmann.
4. *Crassonemertes robusta* Brinkmann.
5. *Bürgeriella notabilis* Brinkmann.
6. *Dinonemertes investigatoris* Laidlaw.
7. *Nectonemertes mirabilis* Verrill (including also *N. grimaldii* Joubin, *N. pelagica* Cravens and Heath, *N. japonica* Foshay, and *Hyalonemertes atlantica* Verrill, but not *N. mirabilis* Bürger nor *H. atlantica* Bürger).
8. *N. primitiva* (*N. mirabilis* Bürger).
9. *N. minima* (*Hyalonemertes atlantica* Bürger).
10. *Phallonemertes murrayi* (*Bathynectes murrayi* Brinkmann).
11. *Chuniella lanceolata* Brinkmann.
12. *Armaueria rubra* Brinkmann.
13. *Natonemertes acutocaudata* Brinkmann.
14. *Balaenanemertes lobata* (*Nectonemertes lobata* Joubin).
15. *B. hjorti* Brinkmann.
16. *B. lata* Brinkmann.

Students of marine biology will be permanently indebted to Dr. August Brinkmann for his excellent monograph ('17a) on the pelagic nemerteans. This monograph contains a summary of the anatomical features of all the species known to that time, as well as a complete systematic revision of the group, with diagnoses of families, genera, and species. There is also a comparative description of each of the organ-systems of the body, including many peculiarities discovered by himself in a study of the extensive material which had been placed in his hands from several exploring expeditions.

The monograph is illustrated with sixteen quarto plates, fifteen of which are double. It is based on the study of by far the largest collection of pelagic nemerteans ever brought together, and while several of the new species are represented by but one or two specimens, others include a large series, in one case, *Nectonemertes mirabilis*, as many as one hundred and seventeen. This large amount of material has given Brinkmann the opportunity of making comparative studies of the anatomical modifications which distinguish the sexes, as well as those changes which take place during the growth and maturity of the worms. The monograph includes a discussion of thirty-two species, representing eighteen genera, together with five of Joubin's forms which are listed as uncertain species. One genus and four species are described as new to science. The list of species recognized by Brinkmann is as follows: —

1. *Protopelagonemertes hubrechti* (*Bathynemertes hubrechti* (Brinkmann).
2. *Plotonemertes adhaerens* Brinkmann.
3. *Pendonemertes levinseni* Brinkmann.
4. *Planktonemertes agassizii* Woodworth.
5. *P. vanhoffeni* Brinkmann.
6. *Crassonemertes robusta* Brinkmann.

7. *Mergonemertes woodworthii* (*Planktonemertes woodworthii* Bürger).
8. *Bürgeriella notabilis* Brinkmann.
9. *Paradinonemertes drygalskii* Brinkmann.
10. *Dinonemertes investigatoris* Laidlaw.
11. *D. alberti* (*Planktonemertes alberti* Joubin).
12. *D. grimaldii* (*Planktonemertes grimaldii* Joubin).
13. *Phallonemertes murrayi* (*Bathynectes murrayi* Brinkmann).
14. *Chuniella lanceolata* Brinkmann.
15. *C. pelagica* (*Drepanophorus pelagicus* Bürger).
16. *C. agassizii* (*Planktonemertes agassizii* Bürger).
17. *Nectonemertes mirabilis* Verrill (*Hyalonemertes atlantica* Verrill, *Nectonemertes grimaldii* Joubin, *N. pelagica* Cravens and Heath, *N. japonica* Foshay).
18. *N. primitiva* Brinkmann (*N. mirabilis* Bürger).
19. *N. minima* Brinkmann (*Hyalonemertes atlantica* Bürger).
20. *Armaueria rubra* Brinkmann.
21. *Natonemertes acutocaudata* Brinkmann.
22. *Pelagonemertes rollestoni* Moseley.
23. *P. moseleyi* Bürger.
24. *Parabalaenanemertes fusca* Brinkmann.
25. *Probalaenanemertes wijnhoffi* Brinkmann.
26. *Balaenanemertes musculocaudata* Brinkmann.
27. *B. lobata* (*Nectonemertes lobata* Joubin).
28. *B. chuni* Bürger.
29. *B. chavesi* (*Nectonemertes chavesi* Joubin).
30. *B. grandis* Brinkmann.
31. *B. hjorti* Brinkmann.
32. *B. lata* Brinkmann.

Uncertain species.

33. *Planktonemertes zonata* Joubin.
34. *P. sargassicola* Joubin (= *Mononemertes sargassicola* Coe).
35. *P. elongata* Joubin.
36. *P. rhomboidalis* Joubin.
37. *Pelagonemertes richardi* Joubin (= *Gelanemertes richardi* Coe).

In addition to the expeditions already mentioned much of the material for Brinkmann's monograph came from the following explorations: —

1. The expeditions of the Danish Fisheries Investigation steamer THOR in the North Atlantic secured six specimens of *Nectonemertes mirabilis*, one of *Natonemertes acutocaudata* and one of *Balaenanemertes grandis* in 1904; one specimen each of *B. musculocaudata*, *B. lobata*, and *B. grandis* in 1905; and one example each of *Pendonemertes levinsini*, *Phallonemertes murrayi*, *Nectonemertes mirabilis*, *Parabalaenanemertes fusca*, and six of *Balaenanemertes lobata* in 1906.

2. On the Swedish zoölogical expedition of 1900 one example of *Dinonemertes alberti* was taken in the Arctic Ocean at about 71° N.

3. The INGOLF expeditions of 1895 and 1896 secured one specimen of *Phallonemertes murrayi*, two of *Nectonemertes mirabilis*, and one of *Dinonemertes alberti*.

4. On the GAUSS expedition of 1901 a single specimen of *Pelagonemertes rollestoni* was secured.

5. The TJALFE expedition of 1909 brought back eight specimens of *Nectonemertes mirabilis* from the North Atlantic.

6. In 1913 the **Armauer Hansen** collected, also in the North Atlantic, thirteen specimens of *Nectonemertes mirabilis*, two of *Parabalaenanemertes fusca* and one each of *Armaueria rubra* and *Probalaenanemertes wijnhoffi*.

It thus appears that while the number of species of these bathypelagic nemerteans has now been increased to about forty-four, they have been secured only after very extensive explorations.

From this it need not be supposed that these organisms are not to be found in all the areas of the deeper oceans, but rather that the individuals are usually widely separated. But even now only a small portion of the deep strata of water of the great oceans has been sampled with apparatus suitable for the collection of the bathypelagic life.

More recently Coe and Ball ('20) have published the results of a complete anatomical study of the type specimens of *Nectonemertes mirabilis*, confirming the specific identity of that genus with Hyalonemertes. It was found, as Brinkmann ('12) had already postulated, that *Nectonemertes mirabilis* is a sexually dimorphic form, the sexually mature males being distinguished both by the cephalic position of the gonads and by the possession of a pair of slender, muscular tentacles on the lateral margins of the body back of the head. The females of this species, to which Verrill (1892) gave the name *Hyalonemertes atlantica*, have the gonads situated in the interdiverticular spaces throughout the intestinal region of the body and are without tentacles.

The sexual dimorphism of the pelagic nemerteans is the subject of a paper by Coe ('20). This study discusses the evolution of the most widely dimorphic forms, as Nectonemertes, through a series of intermediate types leading from the usual conditions in the nemerteans where both sexes have metameric interdiverticular gonads throughout the length of the intestinal region of the body.

MORPHOLOGICAL PECULIARITIES.

The anatomical terms employed in Bürger's monograph ('95) are followed with few exceptions in this report, for they have been generally adopted by workers in this group. The most conspicuous exception to this terminology which has appeared in the recent literature relates to the order of the layers which constitute the wall of the proboscis. Wijnhoff ('14) has proposed that the layers of this organ be reckoned as if it were entirely evaginated, for since the proboscis arises as an invagination of the anterior wall of the body, the order of the layers of the body-wall which continue into the proboscis are naturally reversed when the organ lies in its usual position. It seems to the writer, however, that much confusion would follow the general adoption of Wijnhoff's proposal, as is done by Brinkmann in his monograph on the pelagic nemerteans ('17a) and other papers, for it seems in direct violation of general usage both in descriptions of anatomical features and as applied to objects in general.

The proboscis is a cylinder which can never meet Wijnhoff's requirement of complete evagination, for when fully everted the entire posterior chamber still remains in its normal, invaginated position. Since in dealing with cylindrical bodies, whether anatomical or otherwise, with reference to the lumen those parts nearest the lumen are invariably termed "inner" and those farther removed from the lumen "outer," as illustrated by the digestive canal, blood-vessels, and the like. It is only in reference to the outer surface of a cylinder or in the case of the body as a whole that the terminology is reversed. The fore-gut, the vertebrate eye, and numerous other organs have an origin closely similar to that of the proboscis in the nemerteans, and yet there is no hesitation in reversing the order of the layers, whereby those which line the lumen are termed "inner" in spite of the fact that they are derived from the "outer" layers of the body-wall.

The fact that the anterior chamber of the proboscis can be everted by a contraction of the body-musculature hardly justifies the assumption of an impossible complete evagination as being the normal position of the organ. For these and other reasons, the usual terminology will be retained in this report and those layers of the proboscis adjacent to the lumen of the organ will be considered the "inner" layers.

Another term in which it seems impossible to follow the lead of Brinkmann concerns the pair of nerves found in many pelagic nemerteans just internal to the body-musculature on the dorsolateral aspects of the proboscis-sheath. These nerves appear to be homologous with the dorsolateral nerves of other worms, and are so called in preference to the use of Brinkmann's proposed "subdorsal."

The special adaptations of these worms to a pelagic existence far beneath the surface of the ocean have led to numerous modifications of the organ-systems as found in their littoral relatives. Most of these modifications, as will be explained below, are due to the loss or reduction of structures which are found in a more highly organized condition in the Drepanophorus-like forms from which the pelagic nemerteans are thought to have been descended.

Aside from the flattened or somewhat fish-like shape of the body, the most striking external feature of many of these worms is their translucency, due to the great development of the gelatinous tissue, or parenchyma, which separates the organs of the body.

SHAPE OF BODY

Although the body is flattened in all the pelagic forms, there is great difference in the extent to which the body-musculature is developed. In those forms which have reached the greatest breadth in proportion to their thickness, as Planonemertes, Planktonemertes, Mergonemertes, and Pelagonemertes, the body-musculature is much reduced and the body adapted for floating at particular depths rather than for active swimming. The great development of the parenchyma in these forms serves to enhance the ease of floating due to the high content of water and correspondingly low specific gravity.

In the very broad forms, as Dinonemertes (Figure 1, *i*), the posterior end of the body is particularly flat and is broadened horizontally into a very efficient caudal fin. In correlation, the longitudinal musculature is well developed and is differentiated into two broad plates, one on the dorsal and the other on the ventral side of the body and connected with the corresponding surfaces of the caudal fin. By the contraction of these two powerful muscular bands the caudal fin can be moved with much force and propel the body through the water. Such forms are thus well adapted for swimming.

In Nectonemertes and Balaenanemertes the caudal fin is often more or less distinctly bilobed and remarkably broad and thin, furnishing one of the best examples of a locomotor organ. Frequently the lateral margins of the body are likewise prolonged to form a pair of horizontal fins. These forms can swim readily in any direction, but furnish the greatest resistance to gravity when lying or swimming horizontally. Their tentacles, too, must aid in maintaining the position of the worms without muscular effort.

In the genus Protopelagonemertes (Figure 1, *e*) the body is slender, pointed at both ends, and very little flattened, while in Plotonemertes (Figure 54) and Pendonemertes (Figure 56) it is swollen anteriorly and narrowed behind. These forms are therefore looked upon as the most primitive of the pelagic nemerteans because they most resemble the species of Drepanophorus. In internal organization also they indicate their relationship with such a littoral type. On the other hand, it is by no means certain that they or their relatives, may not have been the ancestors of Drepanophorus, but everything points toward the Protonemertea as the most primitive nemerteans and not the more highly organized Hoplonemertea such as Drepanophorus.

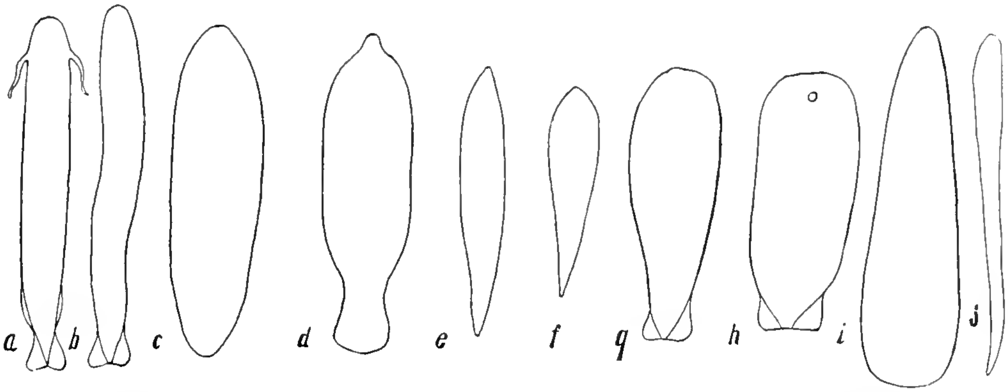


FIG. 1.—Outlines of the bodies of several species of pelagic nemerteans to show variation in shape, with adaptation for swimming or floating:—a, *Nectonemertes mirabilis* Verrill, male; b, *Nectonemertes pelagica* Cravens & Heath, female; c, *Planktonemertes agassizii* Woodworth; d, *Neuronemertes aurantiaca* Coe; e, *Protopelagonemertes hubrechti* Brinkmann; f, *Cuneonemertes gracilis* Coe; g, *Pelagonemertes brinkmanni* Coe; h, *Proarmaueria pellucida* Coe; i, j, dorsal and lateral views of *Dinonemertes investigatoris* Laidlaw.

On the hypothesis that the pelagic forms have been derived from the littoral Polystylifera, Brinkmann ('17a) has shown that it is possible to arrange the known genera and species into families which show a gradual modification of the Drepanophorus-like form into the broad, flattened body of Planktonemertes, or the slender Nectonemertes, or the short, wide, gelatinous Pelagonemertes. Strangely enough, the tentacles, which, aside from the prolongations of the lateral margins of the body in the shape of fins, are the only external appendages found in the nemerteans, occur in two genera, Nectonemertes and Balaenanemertes, which from their internal organization appear to be rather distantly related. The rudimentary condition of the dorsal vessel, the presence of the nerve-cord muscle, the formation of peculiar cephalic sense-organs and general organization of the body, aside from the caudal fin, in Balaenanemertes are so different from the conditions found in Nectonemertes that Brinkmann ('17a) looks upon the tentacles as having arisen independently in the two genera; that is, by convergence. The fact that these appendages are sex-limited in the latter genus but not in the former, lends support to this view. Aside from the tentacles, Balaenanemertes agrees closely with the other genera constituting the Pelagonemertidae. Further investigations will be necessary in order to show whether tentacles occur in yet undiscovered forms which may link the two genera more definitely.

SIZE

There is also great variation in the size of the pelagic forms, the sexually mature specimens of most of the species of Balaenanemertes being only 6 to 10 mm. in length and the species of Armaueria, Probalaenanemertes, and Natonemertes, are of about the same size, while the largest known specimen of *Dinonemertes investigatoris* was 203 mm. long, 56 mm. wide, and 15 mm. thick. This is the largest pelagic nemertean known at present, although *Dinonemertes alberti* reaches a length of at least 85 mm. Mature specimens of *Nectonemertes mirabilis* are upwards of 60 mm. long, while those of *N. minima* are not known to exceed a third this length.

Only a few forms are relatively thick. The single known specimen of *Balaenanemertes chuni*, however, was almost as thick as wide, and *Chuniella pelagica* is only moderately flattened anteriorly.

COLOR

All of the species are more or less translucent and some of them, particularly Pelagonemertes (Plate 2) are almost transparent, being like Sagitta or the pelagic tunicates or medusans in this respect. In the more transparent forms, the digestive system is opaque and often conspicuously colored. The nervous system is also somewhat opaque, the brain and lateral nerves being often of a reddish tinge so that they are easily seen in the living individual or in the cleared specimen. The outlines of the blood-vessels are also visible, while the gonads are conspicuous because of their opacity.

Many of the species are brilliantly colored in life, shades of red, scarlet, orange, and yellow being the most usual colors (Plate 1, fig. 1–8). After preservation, the colors usually disappear entirely, and the body loses most of its translucency except in species of the genus Pelagonemertes. On this account the colors of the living worm are unknown in the majority of the species, for these have been described from specimens preserved without color-notes.

Body-Walls

The epithelial covering of the body is, almost without exception, missing on the greater part of the body in the specimens after preservation. There are, apparently, two causes for the loss of this covering:— first, the sheet of epithelium is less firmly attached to the underlying basement-layer than in littoral forms, and is therefore readily dislodged in handling, and, secondly, the configuration of the surface of the basement-layer, which is convoluted and pitted for the attachment of the epithelial cells, is so changed by the alteration in pressure while the worm is being brought to the surface of the sea that the epithelial layer is loosened. In other cavities, such as the rhynchodeum, connected with the surface of the body the epithelium is also often dislodged, indicating that the change in pressure is the important factor, for this could not have been injured in handling. Sometimes also, the entire epithelial lining of the anterior proboscis-chamber is similarly lost. This is particularly the case in species of Pelagonemertes where the epithelium rests on an enormously thickened basement-layer.

In those parts of the body where present, the epithelium is thin and delicate, but shows the same general arrangement of ciliated and glandular cells that occur in littoral forms. The ciliated cells, however, are somewhat less numerous, and the gland-cells are of two kinds:— those filled with a granular secretion, and those with a clear mucous secretion (Figure 2). There are no other integumentary glands, and the worms apparently secrete much less mucus than do the littoral species.

A basement-layer of considerable thickness covers all parts of the body. Its surface is provided with closely placed cup-like pits or with convolutions for the attachment of the epithelium (Figure 2), and when examined with a lens often shows a division into hexagonal, pentagonal, or irregular fields.

Muscular Systems

The muscular layers of the body-walls are relatively thin as compared with littoral forms, indicating that these worms have but little ability to change the shape of the body. The circular muscular layer is particularly weak, consisting in many cases merely of isolated bands of muscle, separated by much parenchyma (Figure 2).

In Pelagonemertes, the muscular layers are even more reduced than in the other genera, and are not distinguishable as continuous layers in the head, nor along the lateral margins of the body (Plate 13, fig. 175–177).

The longitudinal musculature is better developed than is the circular layer, but this layer also is often almost completely lacking in the head and along the lateral margins of the body. In most species there is a broad band of longitudinal muscles along the dorsal surface of the body and a similar band on the ventral side (Figure 18–20). Each of the bands becomes thinner in the median line and in some forms disappears entirely, giving rise to a right and left muscular band. This more often occurs on the dorsal than on the ventral surface. In some species the ventral band of longitudinal muscles is somewhat thicker than the dorsal, although in most forms they are of about equal thickness (Figure 3).

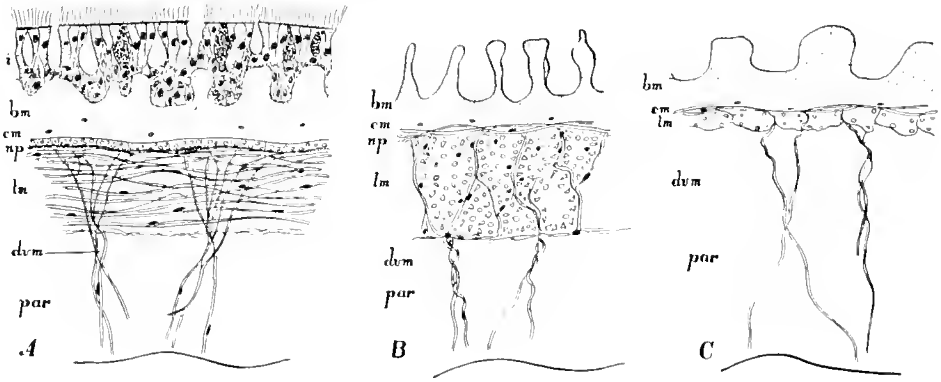


Fig. 2.— Comparison of body-walls of three species of pelagic nemerteans to show modification of musculature. A, longitudinal section of portion of body-wall of *Planktonemertes agassizii* Woodworth, showing the thick basement-layer (*bm*), with corrugated external surface upon which the ciliated integument (*i*) is imbedded. B, portion of transverse section of *Neuronemertes aurantiaca* Coe, showing the thin circular muscular layer (*cm*) and the massive longitudinal musculature (*lm*); the integument was entirely dislodged during capture. C, portion of transverse section of *Pelagonemertes brinkmanni* Coe, showing the very thick basement-layer (*bm*), the extreme reduction of the muscular layers (*cm* and *lm*), and the great development of the parenchyma (*par*); *dvm*, dorsoventral muscles; *np*, intermuscular nervous plexus.

The body-musculature is much stronger in the posterior portions of the body than elsewhere and becomes gradually thinner toward the head, the walls of which contain only isolated bundles. In the posterior third of the body the longitudinal bands reach their maximum development, showing that the worm depends mainly upon this part of the body, as does the fish, for locomotion.

Dorsoventral Musculature. The dorsoventral muscles are very highly developed in these forms. From the anterior end of the body backward they first appear along the lateral margins and gradually increase in abundance and extend nearer to the median line until in the caudal fin they make up the greater part of the body-musculature (Plate **19**, fig. 117). These muscles are provided with conspicuous nuclei in their middle portions and are interlaced dorsally and ventrally with the circular musculature (Plate **19**, fig. 116).

The dorsoventral muscles are in all cases limited to the spaces between the intestinal diverticula in the regions where these are present. A remarkable adaptation of these muscles is described in this report for *Neuronemertes aurantiaca*, where they so closely invest the spermaries that they apparently aid in the forcible discharge of the spermatozoa (Plate **12**, fig. 80).

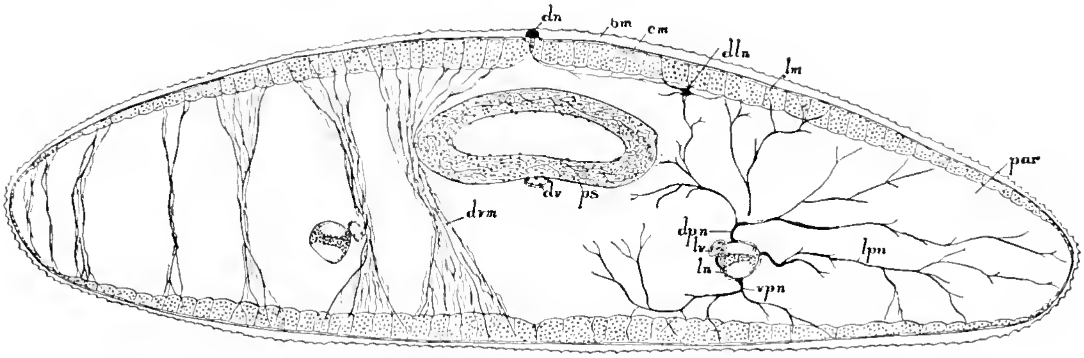


FIG. 3.— Diagram of the musculatures of the body of *Neuronemertes aurantiaca* Coe, showing the thin, outer circular muscular layer (*cm*) beneath the basement-membrane (*bm*) around the entire circumference of the body; the longitudinal musculature (*lm*) forms two thick bands along both dorsal and ventral surfaces of the body, but is very thin along the lateral margins and in the median line. On the left half of the section are shown the dorsoventral muscles (*dvm*), interlaced with the longitudinal musculatures in each of the spaces between the intestinal diverticula, connect the dorsal and ventral body-walls; *ps*, proboscis-sheath, with interlacing circular and longitudinal muscular fibers; *ln*, lateral nerve; *dv*, dorsal vessel; *lv*, lateral vessel. On the right half of the section are shown the principal branches of the lateral nerve in one of the interdiverticular spaces; *dpn*, *lpn*, and *vpn*, dorsal peripheral, lateral peripheral, and ventral peripheral, respectively; *dn*, dorsal nerve; *dln*, dorsolateral nerve.

Cephalic Musculature. In the bathypelagic nemerteans the muscular layers of the body-wall become much reduced in the head, the overlying basement-layer being separated from the cephalic parenchyma by an extremely thin musculature. In Pelagonemertes both the circular muscules and the longitudinal muscular layer are represented merely by small, isolated muscle-bundles consisting of but a few fibers each (Plate **29**, fig. 179). The cephalic wall in *Pelagonemertes brinkmanni* is of such delicacy that the change in pressure when males of this species are brought from their natural habitat to the surface of the ocean causes the rupture of the cephalic tissues, forcing the spermaries to the exterior (Plate **26**, fig. 165).

In some other forms the cephalic walls are firmer, but in all cases they are very thin, particularly anteriorly, as compared with the walls of the body more posteriorly.

Correlated with the thin cephalic wall is a compensatory outgrowth of the musculature by which the proboscis is inserted into the tissues of the head. This musculature in many forms is very highly specialized and consists of strong bands of muscles extending radially through the cephalic parenchyma from the junction of proboscis and proboscis-sheath to become interlaced with the musculature of the cephalic wall on the dorsal and ventral sides of the head in the brain-region. So characteristic of the various species are these muscles that they are fully described in one of the following chapters under the head of proboscis-attachment muscles.

Tentacular Muscles. In the region of the tentacles, as well as in the tentacles themselves, in Nectonemertes and Balaenanemertes, the dorsoventral muscles are especially well developed (Plate **17**, fig. 110, 111). The special musculature of the tentacles in these two genera shows an interesting modification of the layers of the body-walls, as described by Coe and Ball ('20) for *N. mirabilis* (Figure 4).

The tentacles arise as lateral outgrowths of the body-walls immediately back of the head. They consist mainly of strong muscle-bundles directly continuous with the muscular layers of the body-wall, as described by Cravens and Heath ('06) and also by Bürger ('09). The musculature is covered by a well-developed basement-layer similar to that of the body-walls. There are four distinct sets of muscles instead of the three in the body-walls. These are:—(*a*) the outer longitudinal muscular layer which is a direct continuation of the circular musculature of the body, but which runs throughout the tentacle longitudinally; (*b*) the very thick circular muscular layer, derived from the longitudinal body-muscles, which change their direction,

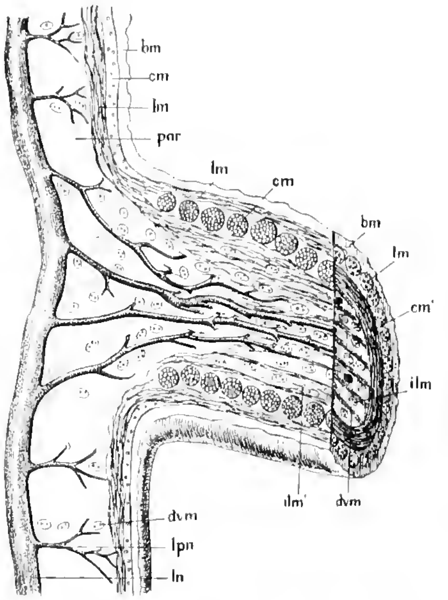


FIG. 4.— Diagram of portion of tentacle and adjacent body-wall of *Nectonemertes mirabilis* Verrill, showing the innervation of the tentacle by means of four large nerves from the lateral nerve-cord (*ln*), homologous with the lateral peripheral nerves (*lpn*) of the rest of the body; *bm*, basement-layer; *cm*, circular musculature and *lm*, longitudinal musculature of body-walls, becoming respectively *lm'*, longitudinal muscles and *cm'*, circular muscles of the tentacle; *ilm'*, internal longitudinal muscles; *dvm*, dorsoventral muscles; *par*, parenchyma.

first becoming diagonal and then assuming a circular or spiral course through the whole extent of the tentacle; (*c*) the inner longitudinal muscular layer, which arises mainly from the circular muscles of the body; and (*d*) the dorsoventral bundles, which are here very highly developed and pass at right angles through the inner longitudinal muscles to connect the dorsal and ventral portions of the circular tentacle-muscles.

Spermatic Muscles. In Nectonemertes and Pelagonemertes, and to a lesser degree in some of the other genera, the spermaries are surrounded by a thick layer of spiral muscles (Plate 18, fig. 113, 114; Figure 5), the contraction of which serves to forcibly eject the spermatozoa during the act of insemination. These are described in the chapter on reproduction.

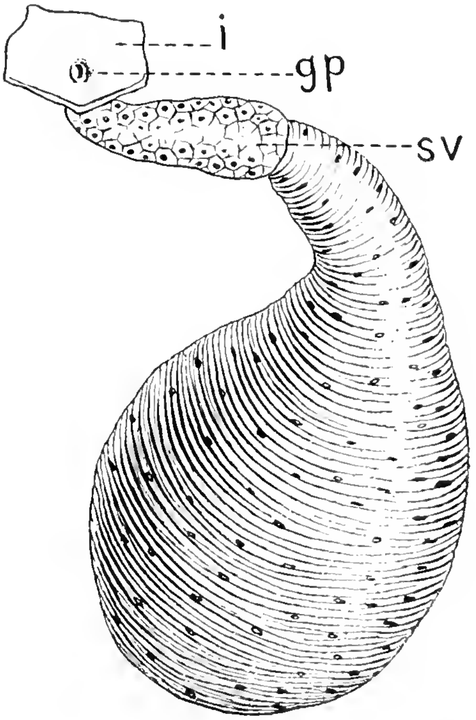


FIG. 5.—Spermary with spiral musculature *Nectonemertes mirabilis* Verrill, *sv*, seminal vesicle, opening through a minute papilla (*gp*) on the surface of the integument (*i*).

Nerve-Cord Muscle. In the genera Armaueria, Cuneonemertes, Pelagonemertes, Natonemertes, Pendonemertes, Balaenanemertes, Parabalaenanemertes, and Probalaenanemertes, a narrow band of muscular fibers splits off from the proboscis-sheath on each side of the body immediately behind the brain and extends backward throughout the length of the body in close connection with the lateral nerve-cord. This muscle appears to reach its greatest development in *Balaenanemertes chuni*, where it almost equals the lateral nerve-cord in diameter. In this form the muscle lies closely pressed against the median border of the neurilemma, and extends posteriorly even beyond the nerve-commissure in the tail.

In *Pendonemertes levinsini* this muscle is nearly half the diameter of the lateral nerve-cord (Figure 57) and extends from its origin from the circular musculature of the proboscis-sheath near the brain to the commissure of the lateral nerves at the posterior end of the body. It lies closely appressed to the neurilemma on the dorsomedian aspect of the nerve-cord. At its posterior end it penetrates the neurilemma.

More usually the nerve-cord muscles are very thin bands closely pressed against the outer neurilemma of the medial border of the nerve-cords, or even imbedded in the connective tissues of the neurilemma. In *Pelagonemertes joubini*, for example, these muscles are the thickness of a single muscular fiber only and are entirely covered by the outer neurilemma (Plate **25**, fig. 161). Such is likewise the case in *Cuneonemertes gracilis* (Plate **24**, fig. 148).

These muscles commonly originate as a single strand of fibers continuous with the spiral fibers of the proboscis-sheath on each side of the body, but in *Pelagonemertes joubini* the first strand appears to be supplemented by several additional strands which enter the neurilemma at several points both on the dorsomedian and on the ventral aspects of the cord (Plate **25**, fig. 161). In this species the nerve-cord muscle in the anterior part of the body consists of two bands of longitudinal fibers for each of the nerve-cords. One of these bands occupies the dorsomedial border of the nerve-cord and the other the ventral border (Plate **25**, fig. 161; Figure 6). Farther back in the body the two muscles fuse to form a single medial band. Both receive more than one muscle-bundle from the muscles bordering the proboscis-sheath.

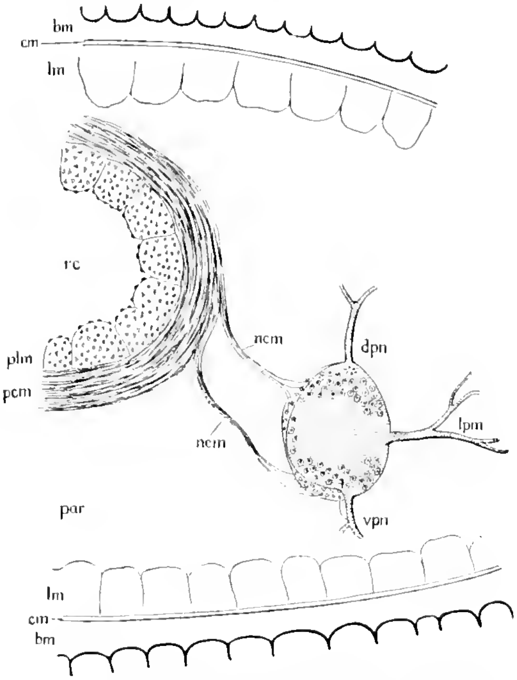


Fig. 6.— Diagram of portion of transverse section of body of *Pelagonemertes joubini* Coe immediately posterior to the brain to show the origin of the nerve-cord muscles (*ncm* and *ncm'*) from the outer, spiral musculature (*pcm*) of the proboscis-sheath; *bm*, basement-layer of body-wall; *cm*, circular musculature and *lm*, longitudinal musculature of body-wall; *dpn*, *lpn*, and *vpn*, dorsal, lateral, and ventral peripheral nerves, respectively; *par*, parenchyma; *plm*, longitudinal muscular layer of proboscis; *rc*, rhynchocoel.

The dorsomedial band originates from a group of muscle-fibers in close connection with the lateral border of the proboscis-sheath immediately posterior to the brain-commissures. This bundle runs parallel with the sheath for some distance posteriorly before it enters the neurilemma of the cord. This primary bundle is supplemented by several smaller bundles, each of which arises from the muscles bordering the sheath and passes to the neurilemma in a similar manner. Some five or six of these supplemental bundles are found but it is quite possible that several of the more posterior ones originate as a single bundle which has a corresponding number of insertions in the cord. The points of insertion correspond with the groups of peripheral nerves (Plate **25**, fig. 161).

The ventral band originates as a larger bundle from about the same region as the primary dorsomedial band but it is inserted farther back in the cord, running for a considerable distance as a cylindrical bundle in the parenchyma beneath the cord. The dotted lines (Plate **25**, fig. 161) indicate the size and position of this bundle before it enters the cord. A curious feature of the ventral band is the giving off of a fiber or two in company with the ventral peripheral nerve at several points along the cord (Plate **25**, fig. 161). This accompanying fiber appears to run along with the nerve until it branches, and then becomes attached in the connective sheath of the nerve.

The function of the nerve-cord muscle is doubtless to hold the nerve-cord in position, with respect to the organs which it innervates.

Stomach-Musculature. In several species belonging to widely separated families special bands of muscles, associated either with the radial bundles of cephalic muscles or with the dorsoventral musculature, are inserted in the walls of the stomach. These muscles are well shown in Brinkmann's figure of *Dinonemertes alberti* ('17a). In Plotonemertes small branches of the dorsoventral bundles passing between the dorsal and ventral cephalic walls are distributed to the stomach. In other cases, as in Pelagonemertes, muscular fibers to this organ branch out from the proboscis-attachment muscles which connect the lateroventral portions of the body-walls with the proboscis-insertion. In *Pelagonemertes brinkmanni* an additional pair of very thin muscular bands originate in the dense musculature of the proboscis-insertion ring and pass posteriorly immediately beneath the ventral ganglia to become inserted in the dorsal wall of the posterior end of the stomach.

The function of this stomach-musculature is evidently to hold the organ firmly in place among the gelatinous tissues of the head when the proboscis is everted, as well as to facilitate the ingestion of food.

Finally, in Protopelagonemertes, there are transverse muscle-bundles which pass directly from the lateral wall of the body to their insertion in the stomach (Brinkmann '17a).

PARENCHYMA

Except where the excessive development of the digestive system inhibits its extension, the bodies of the pelagic nemerteans consist to a very considerable extent of gelatinous parenchyma. To this tissue the translucency of the body is due. It is especially characteristic of Pelagonemertes, where the internal organs are widely separated. Through it the nerves and blood-vessels, as well as the other organs, are easily visible in life and after clearing in preserved specimens (Plate **15**, fig. 98; Plate **16**, fig. 103). This substance suffers great shrinkage in alcohol and the other media used in the preparation of microscopic sections, so that in these sections the internal organs appear much closer together than in life. To this tissue also is largely due the enormous decrease in the bulk of preserved specimens as compared with the same individuals in life. Such decrease leaves some of the preserved specimens with less than one fourth their original volume.

In some of the species the parenchyma is much reduced by the development of the intestinal diverticula.

In *Mergonemertes woodworthii*, for example, these diverticula are so voluminous and so closely appressed that they fill the entire space within the body-walls thereby obliterating the parenchyma almost entirely.

Caudal Fin

In most pelagic nemerteans, the posterior extremity is much flattened by the great development of dorsoventral muscles, and is provided with broad bands of longitudinal muscles on both dorsal and ventral sides. By the contraction of these longitudinal muscles, the extremity can be used as a true locomotor organ. In only a few forms is the posterior extremity pointed, as it is in most littoral species, but in all others is widened and flattened into a more or less highly specialized caudal fin.

Although there is great diversity in the extent to which they are developed, there are three fairly distinct types of these fins. In the more simple type, as exemplified by Planktonemertes, the entire body is very broad and flat, with almost parallel lateral margins which extend with little diminution in width to the posterior end of the body. The intestinal canal, however, becomes much narrower posteriorly, and the dorsoventral muscles draw the body-walls close together to form a broad fin on either side of the rectum (Figure 7). The posterior extremity may be either broadly truncated or slightly bilobed.

In the second type, of which Pelagonemertes shows an example, the body is distinctly narrowed some distance anterior to the end of the body and then broadens out to form a distinct, usually bilobed, fin. In such forms the intestinal diverticula are very small or wanting in the base of the fin, resulting in a relatively long rectum (Figure 21–23). In Nectonemertes and related forms, the caudal fin reaches its highest specialization, and illustrates the third type. The fin is here very broad, with a distinct, and much narrower, base and is provided with a powerful musculature (Figure 7). It may be bilobed or truncated according to the state of contraction. It is also associated with a pair of horizontal fins, as described below.

The movements of the fin depend upon the contraction of the two pairs of broad bands of longitudinal muscles which constitute the greater bulk of the body-walls. One pair of these bands is situated symmetrically in the dorsal wall of the body, with a similar pair in the ventral wall. They are not distinctly separated, however, but the members of both pairs are connected by a thinner layer in the median line, while the lateral borders of each pair are continued as scattered bundles of fibers which come in contact along the lateral margins to make the longitudinal layer more or less continuous around the entire circumference of the body.

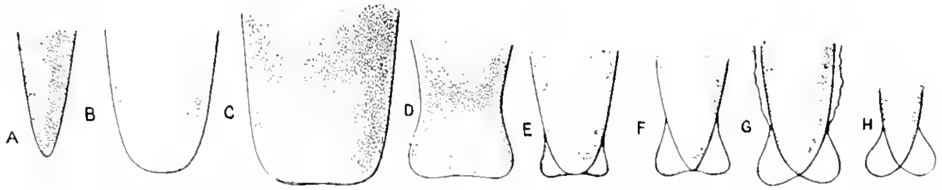


Fig. 7.— Diagrams of posterior extremities of the bodies of eight genera of pelagic nemerteans to show the extent of development of the caudal fin. A, *Cuneonemertes gracilis* Coe, with slender, subcylindrical posterior end; B, *Planktonemertes agassizii* Woodworth, with flattened, rounded extremity; C, *Dinonemertes investigatoris* Laidlaw, with extremely flat, truncate end; D, *Neuronemertes aurantiaca* Coe, with flat, truncate caudal extremity, but without distinct fin; E, *Proarmaueria pellucida* Coe, with slightly developed caudal fin; F, *Pelagonemertes brinkmanni* Coe, with fairly well-differentiated caudal fin; G, *Nectonemertes mirabilis* Verrill, with highly developed caudal fin and pair of horizontal fins; H, *Balaenanemertes* sp., with extreme development of caudal fin.

Horizontal Fins

In Nectonemertes and related forms, in which the caudal fin is most highly developed, the lateral margins of the body immediately anterior to the base of the caudal are similarly provided with dorsoventral muscles which bring the dorsal and ventral walls of the body so close together as to form a pair of broad horizontal fins. These fins often begin as simple keels near the middle regions of the body, gradually widening posteriorly until they reach their greatest development just anteriorly to the narrowed base of the caudal fin. Here they either end abruptly or continue as simple keels to join the caudal fin.

TENTACLES

In the genera Nectonemertes and Balaenanemertes a pair of slender outgrowths of the body-walls occurs on the lateral margins of the body immediately posterior to the head. In the former genus these organs are found only in the adult males, but in Balaenanemertes they occur in both sexes. They are essentially similar to the body-walls in structure, the integumentary, basement, and muscular layers being practically the same in both. The muscular layers, however, assume a direction more or less at right angles to those of the body.

The tentacles are found in their simplest form in Balaenanemertes, where they develop with the maturity of both sexes (Figure 107–112). Their shape and apparent size depend very largely on the state of contraction both of the body-walls in the vicinity and of the tentacles themselves, so that specific descriptions based on the size or shape of these appendages are unreliable. The same organ may assume the form of a broad, blunt tubercle or a more slender, pointed, flexible appendage reaching a length exceeding half the width of the body. Preserved specimens show these various states of contraction.

As shown in Figure 4, the muscular layers of the body-wall continue directly into the tentacle, but their contraction results in a different effect, for the circular layer of the body-wall becomes the longitudinal layer of the appendage and the longitudinal layer of the body-wall runs circularly around the tentacle. Thus the contraction of the former shortens the appendage and moves it to and fro, while the contraction of the latter makes it longer and more slender (Figure 111). Dorsoventral muscles are highly developed in the tentacle and supplement the action of the two other musculatures. Much parenchyma occurs between these muscles and fills the body of the appendage.

The tentacles of Nectonemertes are much larger than those of Balaenanemertes and somewhat more complicated in structure, for a thick inner longitudinal layer is added and large nerves pass between the muscular bundles of the organ (Plate **17**, fig. 110, 111). The epithelial and basement-layers are similar to those of the body-walls, but may become much thickened when the organ is strongly contracted (Figure 8).

The musculature of the tentacles thus consists of four distinct sets of muscles instead of the three in the body-walls. These are: — (*a*) the outer longitudinal muscular layer (Plate **26**, fig. 110, 111, *lm'*), which is a direct continuation of the circular musculature of the body but which runs throughout the tentacle longitudinally; (*b*) the circular muscular layer (*cm'*), of great thickness, which is derived from the longitudinal body-muscles, which change their direction, first becoming diagonal and then assuming a circular or spiral course through the whole extent of the tentacle; (*c*) the inner longitudinal muscular layer (*ilm*) which arises mainly from the circular muscles of the body; the latter become much thicker at the base of the tentacle, sending off not only the outer longitudinal muscles of the tentacle, but also oblique bundles which pass through the longitudinal muscles of the body-wall to form this internal longitudinal layer of the tentacle; (*d*) the dorsoventral bundles (*dvm*) which are here very highly developed and pass at right angles through the inner longitudinal muscles to connect the dorsal and ventral portions of the circular tentacular muscles. These dorsoventral bundles are more or less closely interwoven with the circular muscles on the lateral borders of the tentacle, the individual bundles separating from them more and more toward the median line of the organ (Plate 26, fig. 111).

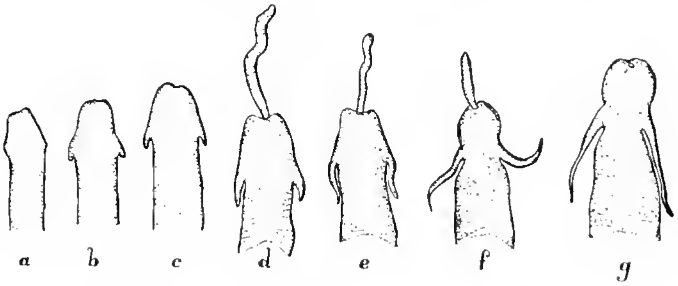


Fig. 8.—*Nectonemertes mirabilis* Verrill. Anterior portions of seven males, showing successive stages in the development of the tentacles, correlated with the maturity of the gonads. A, length of body, 21 mm.; spermaries with but slightly differentiated muscular and germinal cells. B, length 25 mm.; spermatogonia make up the bulk of the germinal cells. C and D, intermediate stages leading to E which measured 34 mm. in length and the spermaries of which contained not only spermatogonia, but also spermatocytes and spermatids. F, length 40 mm.; few spermatogonia remain, the bulk of the germinal cells having been developed into spermatids and ripe spermatozoa. G, tentacles and spermaries fully developed. (After Brinkmann 1917a).

The parenchyma is limited to relatively small areas which lie between the multitudinous muscle-bundles.

Conspicuous nerves leave the lateral nerve-cord in the region of the tentacle and extend the entire length of the organ, sending numerous branches to the musculature and presumably also to the integument. The structure of these organs indicates clearly that they are capable of a remarkably high degree of muscular contraction. The filamentous character of their terminal portions when well developed suggests that they are not simply locomotor organs, for they are particularly well adapted for grasping. When it is remembered that in this genus the tentacles are developed only in males and reach their full size only at the time of sexual maturity, the conclusion seems reasonable that they are then used for grasping the female and clinging to her during the act of insemination. Because of this ability and instinct to cling with their tentacles, the males are sometimes caught on nets or other objects lowered to their habitat, or even on fishing-lines, as reported by Cravens and Heath ('06). As is described more fully in the chapter on reproduction, these appendages have been found in various degrees of development from the condition of small blunt tubercles in the young males to those with long lash-like terminal portions in males with mature sexual products. When fully developed they become two or three times as long as the diameter of the body.

PROBOSCIS-SHEATH

In the majority of the pelagic species the proboscis considerably exceeds the body in length, correlated with a long proboscis-sheath. In a few cases, indeed, this organ may be three or four times as long as the body, being closely coiled in a very large sheath extending to the posterior extremity of the body (Figure 9).

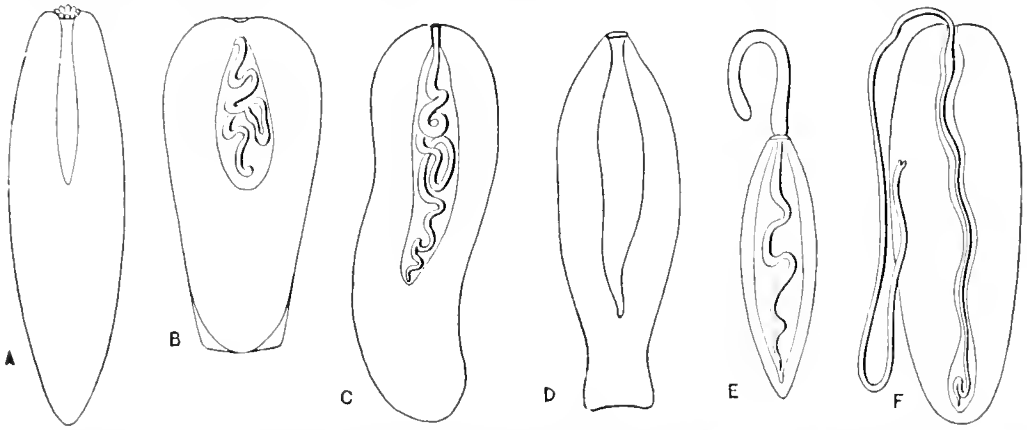


FIG. 9.— Diagrams showing the comparative extent of the proboscis-sheath in six genera of pelagic nemerteans. A, *Mergonemertes woodworthi* (Bürger); B, *Proarmaueria pellucida* Coe; C, *Dinonemertes mollis* Coe; D, *Neuronemertes aurantiaca* Coe; E, *Cuneonemertes gracilis* Coe; F, *Plionemertes plana* Coe. The relative length of the sheath as compared with the body-length increases in the order given.

But in other genera the proboscis is much shorter, and in such cases the sheath may be only three fourths or even less than one half as long as the body. As a general rule, the length of the sheath is so regularly associated with other anatomical features of diagnostic value that this character affords one of the best distinctions for generic diagnosis, although an exception must be made for Balaenanemertes and Chuniella, genera with several apparently closely related species which nevertheless differ decidedly as to the length of the proboscis-sheath.

The relative extent of the proboscis-sheath as compared with the length of the body is shown for several genera in Figure 7. This ratio for the different genera may also be indicated by the following comparison: —

A. Proboscis-sheath about one half, or somewhat less than one half the body-length — Pendonemertes, Mergonemertes, Armaueria, Proarmaueria.
  B. Proboscis-sheath about three fifths the body-length — Phallonemertes.
    C. Proboscis-sheath about two thirds the body-length — Dinonemertes, *Balaenanemertes chuni*, *Chuniella pelagica*.
      D. Proboscis-sheath about three fourths the body-length — Neuronemertes, Plotonemertes, *Chuniella agassizii*.
        E. Proboscis-sheath about seven eighths the body-length — Bürgeriella, Paradinonemertes, *Chuniella lanceolata*, Cuneonemertes, Parabalaenanemertes, Probalaenanemertes, *Balaenanemertes lobata*.
          F. Proboscis-sheath extends practically the entire length of body — Protopelagonemertes, Crassonemertes, Nectonemertes, Natonemertes, Planonemertes, Plionemertes, Planktonemertes, Pelagonemertes, *Balaenanemertes musculocaudata*.

The above classes, however, are by no means sharply demarcated, for the relations of the length of the proboscis-sheath to the body-length depends to some extent on the state of contraction of the body. But it will be noted that in only eight of the genera is this organ very much shorter than the body, and that the genera Chuniella and Balaenanemertes have species belonging to three different classes.

The wall of the sheath is very massive as compared with the frail body-walls. The sheath frequently resembles that of Drepanophorus in having longitudinal, circular, and spiral fibers more or less intimately interwoven to form a single complex layer. This is particularly true of the less specialized genera, such as Protopelagonemertes, Plotonemertes, Pendonemertes, Planktonemertes, Phallonemertes, Crassonemertes, and Neuronemertes (Plate **9**, fig. 62–65). Even in these cases, however, there is a gradual increase in the circular fibers on the inner side of the sheath towards its anterior end where the proboscis is inserted. Such fibers commonly form a fairly distinct inner circular layer near the ring of insertion (Plate **9**, fig. 62).

In Nectonemertes, Chuniella, Balaenanemertes, Cuneonemertes, and Pelagonemertes the sheath is composed of two fairly distinct layers, inner longitudinal and outer circular, but near the ring of attachment these layers are reversed for a short distance, and the longitudinal layer passes forward through the circular layer to take a position external to the latter and thence continues posteriorly past the ring of insertion as the longitudinal muscular layer of the proboscis itself. The circular layer, which here borders the rhynchocoel, likewise continues posteriorly as the outer circular layer of the proboscis.

In Dinonemertes, Planonemertes, Plionemertes and a few other genera there are three more or less distinct muscular layers throughout the entire length of the sheath, the longitudinal musculature lying between two circular layers, of which the outer is relatively thin (Figure 10). Included in both the circular layers, as well as in the longitudinal layers, are scattered fibers which extend spirally and knit the musculatures into a single interwoven tissue. Such spiral fibers are easily distinguished in tangential sections of the sheath. A few longitudinal muscles are also found interwoven with both the circular layers (Plate 14, fig. 95; Figure 10). A similar condition also holds for Armaueria and for Proarmaueria except that in these genera the outer circular layer is very thin. The extreme condition appears to be reached in Bürgeriella, where there are again only two layers, but the outer of these is the longitudinal. Only a few scattered circular fibers are found to represent the outer circular layer, although that is the principal musculature in Cuneonemertes. The relation of the layers is thus exactly reversed (Figure 10).

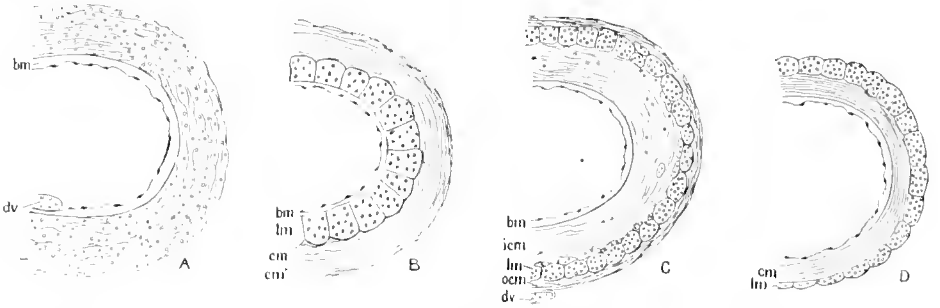


Fig. 10.— Diagrams showing the muscular layers of the proboscis-sheath in four families of pelagic nemerteans. A, *Planktonemertes agassizii* Woodworth, with interlacing circular, spiral, and longitudinal muscles; *bm*, basement-layer underlying the delicate endothelium of the rhynchocoel; *dv*, dorsal vessel. B, *Cuneonemertes gracilis* Coe, with inner longitudinal (*lm*) and outer circular (*cm*) muscular layers, of which a few fibers of the latter (*cm'*) are spiral. C, *Plionemertes plana* Coe, with three muscular layers, of which the middle is longitudinal (*lm*); the inner circular (*icm*) is equal in thickness to the two others combined. D, *Bürgeriella notabilis* Brinkmann, with inner circular and outer longitudinal layers.

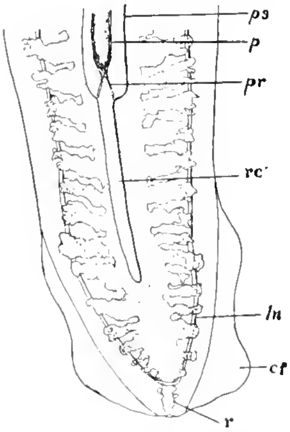


Fig. 11.— Posterior end of female of *Nectonemertes pelagica* Cravens & Heath showing posterior end of proboscis (*p*) attached by a double retractor (*pr*) to the proboscis-sheath; *cf*, caudal fin; *ln*, lateral nerve; *r*, rectum; *rc'*, narrow extremity of the rhynchocoel.

Posteriorly the rhynchocoel tapers to a slender tube and usually ends freely in the midst of the parenchyma and without attachment to the body-walls (Figure 11). In Protopelagonemertes and Crassonemertes, however, the retractor muscles of the proboscis penetrate the dorsal wall of the sheath, to become inserted in the muscular layers of the adjacent dorsal body-wall (Figure 63). In this way a very firm attachment for the retractor is provided.

ATRIUM

In most pelagic forms the mouth and proboscis-openings are separate but in the genera Protopelagonemertes and Planktonemertes there is a common opening on the subterminal portion of the head leading into a short atrium (Plate 5, fig. 42; Plate 6, fig. 49). At the posterior end of the atrium there are two openings, one dorsal to the other. The dorsal opening leads directly into the rhynchodeum and thence to the proboscis while the ventral opening leads to the digestive system.

The atrium is provided with very thin and elastic walls and with a delicate ciliated lining, which is frequently dislodged in the preserved specimens. This chamber is essentially a short infolding of the surface-epithelium and it is probable that in the act of extrusion of the proboscis or in the ingestion of food it may be so distended and everted as to practically disappear.

RHYNCHODEUM

The external proboscis-opening leads to a slender chamber, the rhynchodeum, at the posterior end of which the proboscis is attached to the tissues of the head by a ring of insertion, or attachment, muscles. In some forms the insertion is quite near the tip of the snout, although more frequently it lies immediately anterior to the brain. In most genera broad bands of muscles, the proboscis-attachment muscles, pass from the ring of insection to the musculature of both the dorsal and ventral walls of the head, making a very firm anchorage for the proboscis.

The walls of the rhynchodeum are always very thin and highly distensible, consisting of a fibrous basement-layer on which rests a layer of delicate ciliated cells. In many specimens this epithelium is dislodged while the worms are being brought from their deep habitat to the surface. This chamber is without muscles except for a few circular fibers which form a splincter at its posterior end.

PROBOSCIS-ATTACHMENT MUSCLES

The ring of muscles by which the proboscis is inserted at the anterior end of the sheath is held in place in the midst of the gelatinous tissues of the head by strong strands of radial muscles attached peripherally to the cephalic walls. These proboscis-attachment muscles are well developed in most pelagic forms, but are very delicate or lacking in Bürgeriella, Armaueria, and in the members of the Dinonemertidae.

In those forms in which the proboscis is largest as compared with the body-size these attachment-muscles appear to be most highly differentiated and pass radially from the insertion-ring through the cephalic parenchyma to become interlaced with the musculature on all sides of the head. But in other cases, as in Nectonemertes and Balaenanemertes, they consist of numerous slender strands of fibers directly continuous with the longitudinal muscles both of the proboscis and of the proboscis-sheath. They frequently leave the ring of insertion in two broad radial bands, of which one passes to the dorsal and the other to the ventral surface of the head. Here they become interlaced with the longitudinal muscles of the cephalic walls. Their points of attachment peripherally are frequently distributed in three distinct regions. One of these is a broad zone on the dorsal surface somewhat posterior to the brain, while the other two are placed symmetrically, one on either ventrolateral side of the head. To reach these latter positions, several bundles of fibers originating from the ventral side of the insertion-ring unite into two groups and pass obliquely outward and posteriorly close beside the lateral borders of the stomach.

In *Planktonemertes agassizii* this musculature consists of a pair of broad bands which pass posteriorly and dorsally to the dorsal cephalic wall (Plate **5**, fig. 42), with a similar pair passing ventrally and posteriorly to become attached to corresponding positions in the ventral wall of the head. The effect of these attachments is to anchor the insertion-ring securely in its proper position, not only when the proboscis is everted and withdrawn but also when the mouth and stomach are distended with food.

In *Pelagonemertes brinkmanni* there are five pairs of these muscles, fastened to the dorsal and ventral surfaces of the head at different levels (Plate **27**, fig. 172, 173; Plate **29**, fig. 179–181; Figure 14). The relations of these attachment-muscles are shown diagrammatically in Figure 14. The figure shows that the insertion-ring (*pi*) consists of the interlacing muscular fibers both of the proboscis and of the sheath, the musculatures of one being thus continuous with the other. Also directly continuous with both are the muscular fibers of the attachment-muscles. The five pairs of the latter are firmly attached to the musculature of the cephalic wall by a similar interlacing of fibers.

Two pairs of these attachment-muscles are connected with the ventral cephalic wall while the other three pairs are fastened to the dorsal wall of the head. One pair of the former may be termed the median ventral muscles (*am*) because they pass from the insertion-ring beside the anterior border of the stomach to become attached to the ventral cephalic wall in the brain-region. The exact position of this attachment with respect to the brain depends on the position of the proboscis, for when the latter is in its normal position (Figure 14) the attachment lies somewhat anterior to the brain, while in specimens in which the proboscis is everted (Plate **27**, fig. 172, 173) the brain is drawn forward, bringing the union of these muscles with the cephalic wall a short distance posterior to the brain. The ventrolateral pair of attachment-muscles (Figure 14, *am'*) pass obliquely to corresponding positions on the cephalic walls. Of the three pairs of these attachment-muscles on the dorsal side of the head, the largest are the median dorsal muscles (*am''*; Plate **27**, fig. 173; Plate **29**, fig. 179), which interlace with the musculature of the cephalic wall near the median line. The dorsolateral muscles (*am'''* and *am''''*) extend obliquely outwards to the corresponding portions on the cephalic walls (Plate **27**, fig. 172; Plate **29**, fig. 180). One of these, the anterior dorsolateral muscle, lies somewhat anterior to the posterior dorsolateral, but in the same relation to the median line (Figure 14).

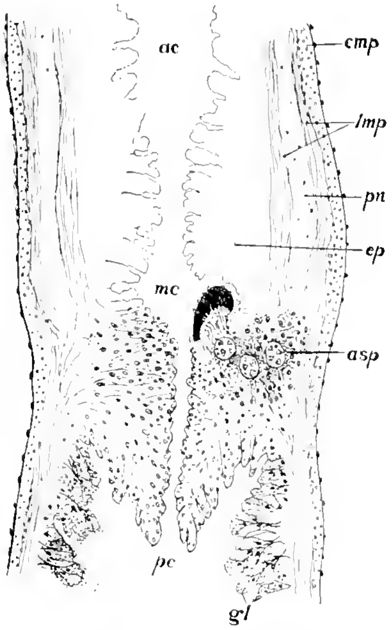


Fig. 12.— Longitudinal section of middle chamber (*mc*) of the proboscis of *Nectonemertes pelagica* Cravens & Heath, with adjacent portions of anterior and posterior chambers, showing the basis armed with minute stylets and three pouches of accessory stylets (*asp*); *cmp* and *lmp*, circular and longitudinal muscular layers respectively; *pn*, proboscis-nerve; *ep*, inner, rhabditic epithelium lining the lumen of the anterior chamber (*ac*); *gl*, gland-cells lining the lumen of the posterior chamber (*pc*).

Proboscis

In general structure the proboscis is likewise essentially of the Drepanophorus type, with a long anterior chamber, an incompletely separated middle chamber and a slender, glandular posterior chamber. Imbedded in the wall of the middle chamber is a minute, curved, sickle-shaped, hook-shaped, or crescentic basis bearing a number of tiny conical stylets on its free surface. There also frequently occur a few small pouches of accessory stylets imbedded in the proboscis-wall near the basis.

In the descriptions of a few species the statement has been made that the proboscis lacked this stylet-apparatus, but such statements should be accepted with caution, for the minute basis is easily overlooked even in faultless series of sections. It is by no means inconceivable, however, that pelagic forms may occur in which this apparatus has entirely degenerated, as is the case in Malacobdella and Gononemertes among the littoral and bottom-living Hoplonemerteans.

There is great variation in the length of the proboscis in the different genera, more or less directly correlated with the extent and size of the proboscis-sheath. In some of the species of Pelagonemertes, for example, the total length of the proboscis is some three or four times that of the body, being coiled and bent upon itself in a voluminous sheath extending to the posterior end of the body. In *Plionemertes plana* (Plate 15, fig. 98, 99) this organ is more than four times the body-length.

The anterior chamber of the proboscis is the largest portion of the organ, although it may be exceeded in length by the slender posterior chamber. The middle chamber containing the armature described above is very small, and only incompletely demarcated from the anterior chamber.

The walls of the anterior chamber consist of three massive layers of muscles with an intervening nervous layer, and is covered both externally and internally with epithelium which rests upon a basement-layer. There is no great difference in the walls of this chamber in the different forms, except in regard to the internal epithelial layer and its supporting basement-layer. In respect to the latter there are two quite distinct types, one of which is represented by *Planktonemertes agassizii*, which has a relatively thin basement-layer (Plate 6, fig. 44), and the other by *Pelagonemertes brinkmanni*, in which this layer is so enormously increased that it far exceeds in thickness all the rest of the layers combined (Plate 4, fig. 29, 30).

In both types the walls consist of a total of nine more or less distinct layers: (*1*) a delicate, flattened epithelium which covers the exterior of the proboscis in its normal position, and which is bathed in the rhynchocoelomic fluid; (*2*) a delicate basement-layer; (*3*) a thin, outer circular muscular layer; (*4*) the external longitudinal musculature; (*5*) the nervous layer, with its cylindrical plexus and longitudinal nerves; (*6*) the inner longitudinal musculature; (*7*) the thin inner layer of circular muscles; (*8*) a thicker basement-layer which is thrown up into great folds and papillae for the reception of (*9*) the columnar epithelium lining the lumen. The latter is generally dislodged during capture and preservation in those species having an extremely thick basement-layer. Towards the posterior end of the anterior chamber, however, the basement-layer becomes thinner, and here the lining epithelium is more often retained.

In the middle chamber the muscular layers become much confused, owing to the special musculature of the basis (Plate **4**, fig. 31), described below.

The walls of the posterior chamber are much thinner than those of the anterior chamber, and its lining epithelium, while still columnar, is much less closely packed than in the anterior chamber. This portion of the proboscis is frequently without papillae, but in some species, papillae are fairly well developed.

The peculiar epithelium of the anterior chamber consists of immense numbers of columnar glandular cells which produce great quantities of rhabdites, and thereby an extremely viscous secretion. The epithelium of the posterior chamber, on the other hand, forms no rhabdites, but secretes great quantities of mucus, for its epithelial cells are crowded with secretion.

Proboscidial nerves. The pelagic nemerteans show a further resemblance to Drepanophorus in having a rather large number of proboscidial nerves. These nerves are branches usually of a large trunk on each side which arises from the ventral commissure at its origin from the brain. They enter the proboscis at its insertion and immediately divide up into a more or less definite number characteristic of the species. They extend posteriorly in the midst of the longitudinal muscular layer to the stylet-region where they form a continuous plexus, or nerve-ring, from which smaller nerves are given off to the posterior proboscis-chamber (Figure 13).

In some species there are only half as many nerves near the posterior end of the anterior chamber as there are near the insertion, for every alternate nerve becomes gradually smaller and eventually disappears in the nerve-plexus connecting the principal nerves. Thus in *Armaueria rubra* there are fourteen nerves in the proximal portion of the proboscis but only seven of these extend the entire length of the anterior chamber.

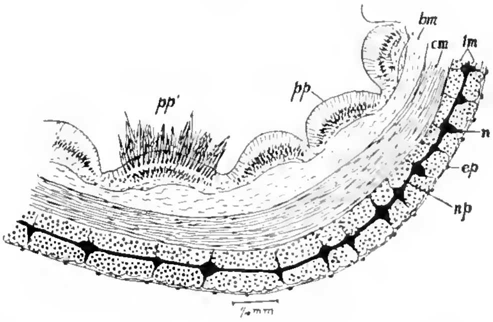


FIG. 13.— Portion of transverse section of anterior proboscis-chamber of *Planktonemertes agassizii* Woodworth, showing the papillae (*pp*) of rhabdite-forming cells, the deeply staining secretion being indicated on one of the papillae (*pp'*); *bm*, basement-layer; *cm*, circular muscles; *lm*, longitudinal muscular layers; *np*, nerve-plexus; *pn*, nerve; *ep*, outer epithelium.

In other forms larger and smaller nerves alternate regularly, the smaller (secondary) ones being situated in the center of the nerve-plexus which connects the primary nerves. Thus in *Planktonemertes agassizii* there are twenty-five primary and an equal number of secondary nerves, and in *Pelagonemertes joubini* fifteen of each. In *Plionemertes plana* there are twenty-four primary nerves with an equal number of secondary nerves in certain parts of the proboscis while other regions of this organ show only nineteen to twenty-three secondaries. That the primary nerves represent the true proboscidial nerves is shown by the fact that their branches divide the longitudinal muscular layer into the same number of separate bundles. The secondary nerves lie in the middle of these bundles.

Further details regarding the proboscidial nerves are to be found in the chapter on the nervous system.

When the proboscis is everted, as shown in Plate **4**, fig. 32, the arrangement of the layers is naturally reversed, and the thick, rhabdite-secreting epithelium covers the external surface. The basement-layer is then stretched until its papillae largely disappear. At the same time the flattened epithelium which covered the exterior before eversion now lines the narrow internal tube and the previously flattened cells are pressed together until they become cubical or even columnar in shape.

Armature. In the pelagic forms the armature is of the Drephanophorus type, although it is much less well developed than in that genus, and in some of the species is quite rudimentary. In *Nectonemertes minima*, for example, the basis is represented merely by a tiny plate bearing a few extremely minute stylets. In most forms the basis is crescentic or irregularly curved, but in other species it is distinctly hook-shaped. It is usually provided with a single row of six to twelve small, conical stylets, but in certain genera, as Bürgeriella and Paradinonemertes, the stylets vary greatly in size and are arranged in several rows.

The armature is brought into action at the tip of the fully everted proboscis, and in preserved specimens it is frequently found in this position (Plate **6**, fig. 45).

The shape of the basis is characteristic of the species, but as this is curved and more or less crescentic its appearance obviously changes according to the direction in which it is seen. In *Pelagonemertes brinkmanni*, for example, where the basis is somewhat sickle-shaped, but curved in three planes, the figures shown on Plate **27** might easily be mistaken for differently shaped objects. When cut transversely or seen in optical cross section the outline is likewise crescentic, but in this case very small, with one of the stylets imbedded in the center of its greater curvature (Plate **6**, fig. 48; Plate **25**, fig. 159).

The basis is imbedded in the wall of the middle chamber of the proboscis with the distal portion of its greater curvature projecting freely into the lumen

(Plate **4**, fig. 31; Plate **6**, fig. 45; Plate **16**, fig. 104; Plate **21**, fig. 126, 127; Plate **25**, fig. 157; Plate **27**, fig. 167–169). It is held in place by a strong and complex musculature inserted along the entire length of the lesser curvature (Plate **6**, fig. 46; Plate **16**, fig. 115; Plate **25**, fig. 158; Plate **27**, fig. 170). The contraction of these muscles doubtless provides the rasping movements which give the organ its effectiveness. They are closely associated with another strong musculature which radiates outward from the region of the basis and interlaces its fibers with the outer portion of the longitudinal muscular layer (Plate **4**, fig. 31).

Deeper in the wall of the middle chamber is an incomplete wreath of large gland-cells (Plate **27**, fig. 169), the secretions of which pass to the vicinity of the basis.

The stylets vary considerably in both shape and size (Plate **6**, fig. 47; Plate **27**, fig. 167–171). Each consists of a tiny conical tooth resting upon a rounded or oval discoid basal portion. It often happens that the tooth has dropped out of its basal disk in preserved specimens (Plate **16**, fig. 105).

The number of stylets seems to be fairly constant for each species, although the number of observations is so small as not to be very reliable. In *Planktonemertes agassizii* the number is about a dozen, likewise in *Balaenanemertes chuni*, while in *Pelagonemertes rollestoni* there are not less than six nor more than ten; in *P. joubini* about eight and in *P. brinkmanni* about seven.

Besides the basis and its stylets, there are in some forms several pouches each containing accessory stylets, similar to those of the basis. The number of such pouches is six or more in *Pelagonemertes rollestoni* (Figure 100) and from nine to twelve in *P. brinkmanni* (Plate **27**, fig. 167, 168). In most of the other species, however, these minute pouches have either not been found or their number not ascertained. Only in exceptional cases is it possible to distinguish them in cleared total preparations, and it is even more difficult to find them in serial sections because of their transparency (Figure 12).

Retractors. The longitudinal muscles of the posterior proboscis-chamber extend beyond the end of the proboscis and usually become interwoven with the muscles of the sheath to form the retractor (Figure 78). In some forms there is a single band of these muscles and in others two. Their insertion in the sheath is often so firm that when the proboscis is spasmodically discharged instead of normally everted, the retractor is ruptured at the point of union with the proboscis and left attached to the sheath. This is the case in Nectonemertes, for example. The sheath usually ends freely in the body-parenchyma, but in

Protopelagonemertes and Crassonemertes the retractor-muscles pass directly through the wall of the sheath and become interwoven with the longitudinal muscles of the dorsal wall of the body (Figure 63).

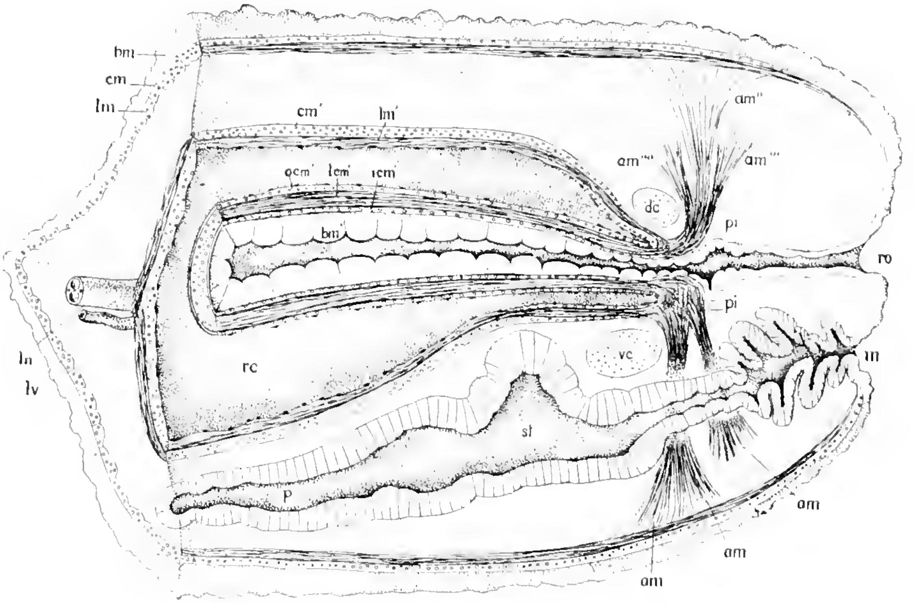


Fig. 14.— Diagram of the anterior end of the body of *Pelagonemertes brinkmanni* Coe, showing the proboscis-attachment muscles of one side of the head; *am*, *am'*, *am''*, *am'''*, *am''''*, median ventral, ventrolateral, median dorsal, anterior dorsolateral, and posterior dorsolateral attachment-muscles respectively; *bm*, *bm'*, basement-layer of body-wall and proboscis respectively; *cm*, *cm''*, circular muscles of body-wall and proboscis-sheath respectively; *dc*, dorsal brain-commissure; *icm*, inner circular muscles of proboscis; *lm*, *lm'*, *lm''*, longitudinal muscles of body-wall, proboscis, and proboscis-sheath respectively; *ln*, lateral nerve; *lv*, lateral vessel; *m*, mouth; *ocm*, outer circular muscles of proboscis; *p*, pylorus; *pi*, insertion-ring of proboscis; *rc*, rhynchocoel; *ro*, rhynchodeal openings; *st*, stomach; *vc*, ventral brain-commissure.

In *Plionemertes plana* the longitudinal musculature of the proboscis continues posteriorly beyond the end of the proboscis as a broad band of fibers forming the retractor. This band is then divided into many smaller bundles which become interlaced among the muscles of the adjacent proboscis-sheath. The outer epithelium of the proboscis which elsewhere consists of but a thin layer of flattened cells here becomes thickened into a massive layer of loosely crowded, overlapping columnar cells (Figure 11).

DIGESTIVE SYSTEM

Mouth. The mouth is usually situated terminally, in close proximity to the proboscis-opening, and leads by a rudimentary oesophagus to the voluminous stomach. From the latter a narrow tube, the pylorus, passes backward to open

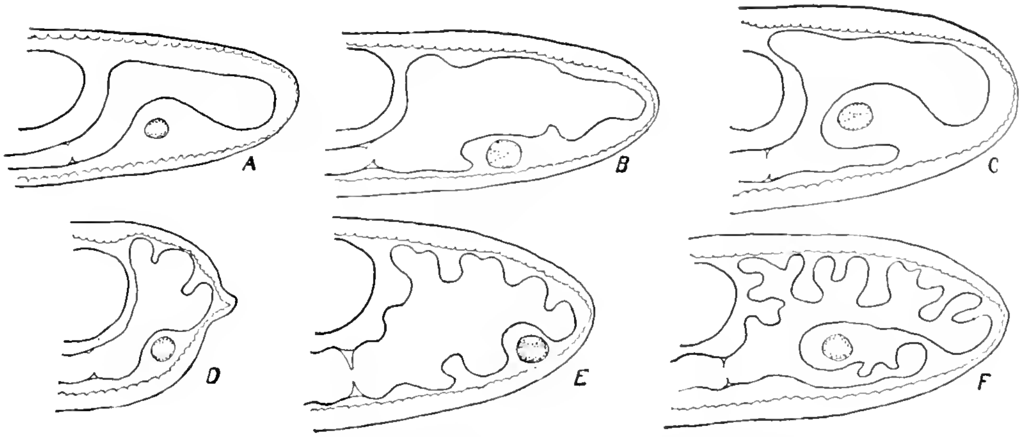


FIG. 15.— Diagrams of portions of transverse sections of the bodies of several pelagic species, showing the character of the intestinal diverticula and the position of the lateral nerves. A, simple type with dorsal branch only (*Pelagonemertes joubini* Coe); B, with rudiment of ventral branch (*Planonemertes lobata* Coe); C, ventral branch extends beneath lateral nerve (*Neuronemertes aurantiaca* Coe); D, with lobed dorsal branch only (*Cuneonemertes gracilis* Coe); E, dorsal branch broad and much lobed, ventral branch rudimentary (*Nectonemertes pelagica* Cravens & Heath); F, dorsal branch much divided, ventral branch well developed and lobed (*Planktonemertes agassizii* Woodworth).

into the dorsal wall of the intestine. The latter is by far the most extensive portion of the digestive tract, and is provided with paired diverticula (Figure 15), which occupy most of the space within the body-walls (Figure 16).

Only in Protopelagonemertes and Planktonemertes is there a common opening for mouth and rhynchodeum. In all the other forms the two openings are more or less widely separated, reaching their greatest divergence in Paradinonemertes, where the mouth lies posterior to the ventral brain-commissure.

Oesophagus. In most pelagic forms the mouth, with its convoluted walls, leads directly into the glandular stomach, so that an oesophagus, strictly speaking, is lacking. In many cases, however, there is a short portion of the digestive tract lying immediately adjacent to the mouth, which is distinguishable from the stomach histologically and which doubtless represents a rudimentary oesophagus (Figure 17).

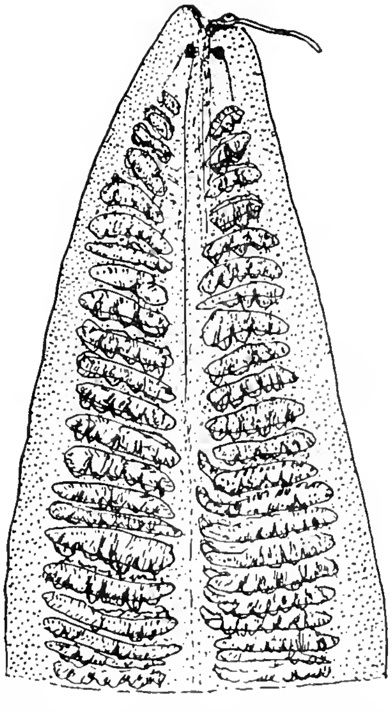


FIG. 16.— *Dinonemertes investigatoris* Laidlaw. Anterior portion of body, showing intestinal diverticula gradually increasing in size as the body widens posteriorly. (After Brinkmann, 1917a).

Stomach. The reduction of the oesophagus brings the stomach forward anterior to the brain-commissures, and only in the more primitive forms does the latter extend posteriorly much beyond the brain. The stomach usually has convoluted, highly glandular walls, but in several forms is described as being very short, narrow, without folds and so greatly reduced that it passes into the pylorus as far forward as the brain-region.

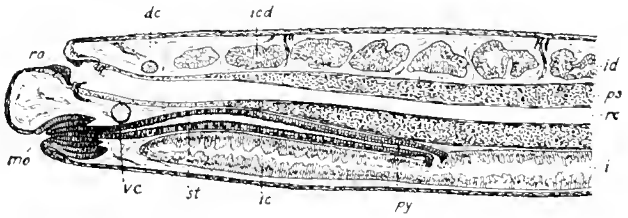


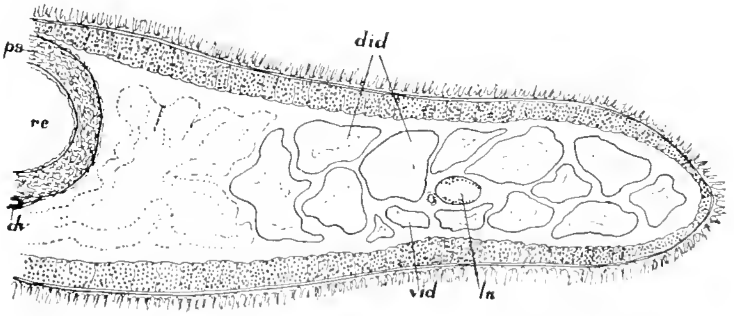
FIG. 17.— Sagittal median section of anterior portion of body of *Nectonemertes mirabilis* Verrill, showing opening of the rhynchodeum (*ro*), attachment of proboscis-sheath (*ps*), mouth (*mo*) with its folds of epithelium, leading through a short oesophagus to stomach (*st*), and the latter to pylorus (*py*); *ic*, intestinal caecum; *icd*, diverticula of same; *i*, intestine; *id*, intestinal diverticula; *dc*, dorsal brain-commissure; *vc*, ventral commissure. × 24.

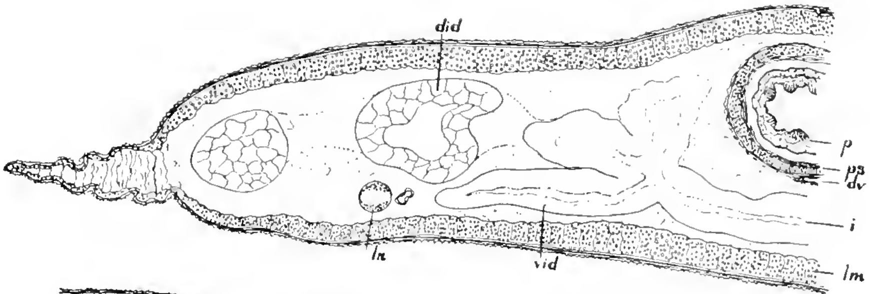
Pylorus. At its posterior end the stomach becomes gradually narrowed into the pylorus. This is a slender tube, without convolutions in its walls and with a gradual decrease in the number of gland-cells posteriorly until only the ciliated cells are found toward its opening into the dorsal wall of the intestine. The length of the pylorus, and the corresponding length of the intestinal caecum, shows great variation, reaching in *Nectonemertes mirabilis* about one eighth the entire length of the body, while in Pelagonemertes it is reduced to but a very small fraction of the body-length.

Intestine. In all the pelagic forms the intestine is provided with paired diverticula, the number of which usually increases with the growth of the body, but in a few species, as *Pelagonemertes brinkmanni*, is nearly constant throughout the growth-stages. The number of these diverticula is correlated also both with the amount of gelatinous tissue within the body-walls, and with the profusion of branches which each diverticulum possesses. They are most numerous in Dinonemertes, Planktonemertes, and Nectonemertes, where fifty to seventy pairs of narrow diverticula are so closely placed that they leave but little space for gelatinous tissue between them. The smallest number occurs in *Pelagonemertes moseleyi* and *P. brinkmanni*, the former species having four, and the latter four to six pairs of these appendages, widely separated by a great amount of gelatinous tissue (Plate 2, fig. 9–15).

In *P. brinkmanni* the diverticula are usually quite without branches, although occasionally the most anterior pair may be more or less distinctly bilobed. In Planktonemertes there is a great profusion of branches and lobes (Figure 18) but the greatest complexity of branching is found in Bürgeriella, where a truly dendritic condition is reached (Figure 65–68).

The diverticula are usually provided with both dorsal and ventral lobes (Figure 19), but in some species the ventral lobe is lacking in the posterior half of the body (Figure 20), and in others it is absent throughout the entire digestive system (Figure 15).





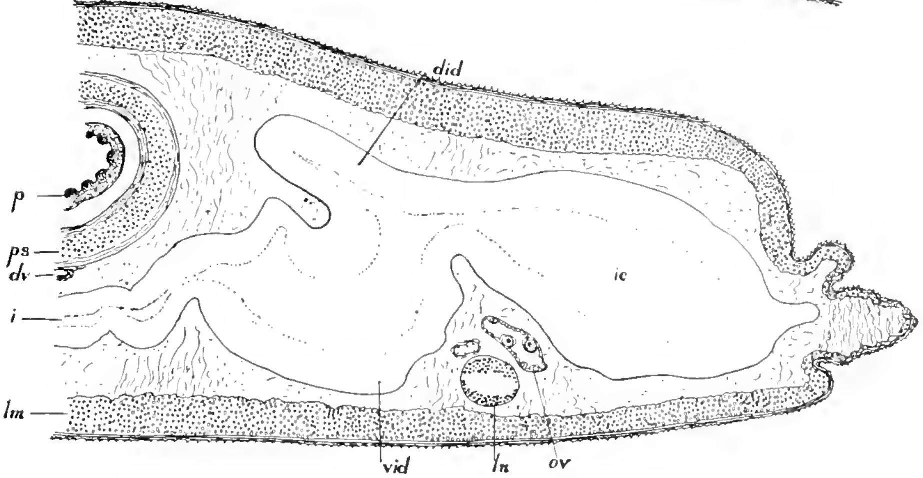


FIG. 18.— *Planktonemertes agassizii* Woodworth. Portion of transverse section of body anterior to the ovaries, showing the many lobules of both dorsal (*did*) and ventral branches (*vid*) of the intestinal diverticula, and the proboscis-sheath of interlacing circular and longitudinal fibers.

FIG. 19.— *Plionemertes plana* Coe. Portion of transverse section posterior to the middle of the body, showing the simple branching of the intestinal diverticula, the three muscular layers of the proboscis-sheath, and the thin lateral margin of the body.

FIG. 20.— *Plionemertes plana* Coe. Portion of transverse section anterior to middle of body, showing a simple intestinal diverticulum in which the ventral branch (*vid*) is represented merely as the ventral wall of the main diverticulum. The lateral margin of the body is much contracted in this particular section.

The epithelium of both the intestine and its diverticula contains a great number of oil-drops. These are in many cases not apparently different from the similar bodies found so abundantly in the intestinal epithelium of littoral species, but in other cases are so numerous and of such large size as to greatly affect the appearance of the more or less translucent body. In some species they are reddish in color and in others yellow, thereby giving a characteristic coloration to the living animal. The colors usually disappear in alcohol, but may be retained for a year or more in formalin (Plate 2, fig. 9).

Such oil-globules not only give the body its specific coloration but because they have a lower specific gravity than the sea-water may be of great service to the worm in enabling it to remain suspended in its own water-layer without muscular effort.

Intestinal caecum. As stated above, the proportions of this part of the digestive system depend upon the position where the pylorus pierces the dorsal wall of the intestine. If the pylorus enters the anterior end of the intestine, as it does in Pelagonemertes, the caecum, if developed at all, is but an inconspicuous ventral lobe. But if, on the other hand, the pylorus extends far back in the body as a slender tube lying on the dorsal wall of the intestine, as in Nectonemertes and most of the other pelagic species, then an equal length of intestine lies as a caecum anterior to the opening of the pylorus.

Caecal diverticula. The conditions mentioned for Nectonemertes result in cutting off a caecum bearing five to seven pairs of diverticula which thus become caecal diverticula, while Pelagonemertes obviously has none.

The most anterior pair of diverticula may arise either from the very anterior end of the caecum or some little distance back from the tip. In the single genus Balaenanemertes are found species which show both these conditions, as well as various stages in the reduction of the number of diverticula from two distinct pairs to none.

Rectum. The intestinal diverticula at the posterior end of the body become gradually smaller and then disappear completely, leaving a narrow canal, the rectum, which opens externally at the tip of the posterior extremity. The opening may be either slightly ventral or dorsal to the exact tip, and may be in a slight depression or at the summit of a small elevation according to the state of contraction of the surrounding tissues.

The configuration of the rectum and adjacent parts of the digestive system is shown in Figure 21–23.

Intestinal epithelium. The epithelial lining of the intestine, intestinal caecum and intestinal diverticula consists of crowded columnar cells of irregular shape. When well preserved two types of cells can be distinguished (Figure 24). The larger and more numerous cells have basal nuclei and their cytoplasm is crowded with vacuoles. Some of these vacuoles in life doubtless contain digestive secretions, while others are filled with the oil-droplets, mentioned above.

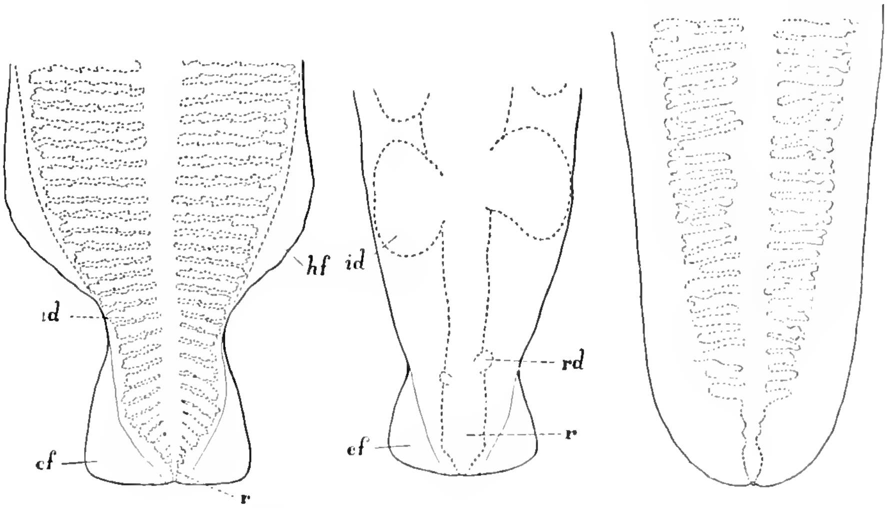


FIG. 21–23. Diagrams of posterior ends of the digestive system. Fig. 21, *Nectonemertes mirabilis* Verrill; Fig. 22, *Pelagonemertes brinkmanni* Coe; Fig. 23, *Planktonemertes agassizii* Woodworth; showing the extreme differences in the number and extent of the intestinal diverticula in different pelagic forms; *cf*, caudal fin; *hf*, horizontal fin; *id*, intestinal diverticulum; *r*, rectum; *rd*, rudimentary diverticulum.

Indications of cilia are occasionally to be seen on the free borders of some of the cells, while similar cells appear to have amoeboid terminal processes. In the second type of digestive cells the cytoplasm is crowded with deeply staining secretion-granules (Figure 24).

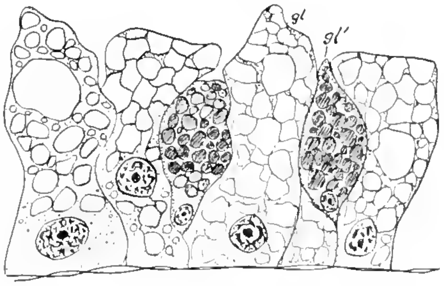


FIG. 24.— Six cells from the intestinal epithelium of *Proarmaueri pellucida* Coe, the larger gland-cells (*gl*) having large, clear vacuoles of secretion and the smaller cells (*gl'*) containing numerous vacuoles filled with yellowish secretion-granules.

VASCULAR SYSTEM

In all the families except the Pelagonemertidae there are three longitudinal blood-vessels which extend nearly the entire length of the body as in the littoral nemerteans. Two of these (the lateral vessels) lie close beside the lateral nerve-cords, while the third (the median, or dorsal, vessel) extends along the ventral side of the proboscis-sheath. In those forms having a short proboscis-sheath the median vessel lies in the parenchyma on the dorsal side of the intestine.

At the anterior end of the body the lateral vessels are united by two anastomoses, one of which lies above the rhynchodeum near the anterior end of the head, while the other is situated beneath the proboscis-sheath and in close contact with the posterior border of the ventral brain-commissure. From this ventral anastomosis the median vessel arises (Figure 25). The dorsal anastomosis is occasionally evaginated into a pair of cephalic lacunae which extend anteriorly for a short distance beside the rhynchodeum. Such lacunae have been found in *Pelagonemertes brinkmanni* (Plate **29**, fig. 179; Figure 25).

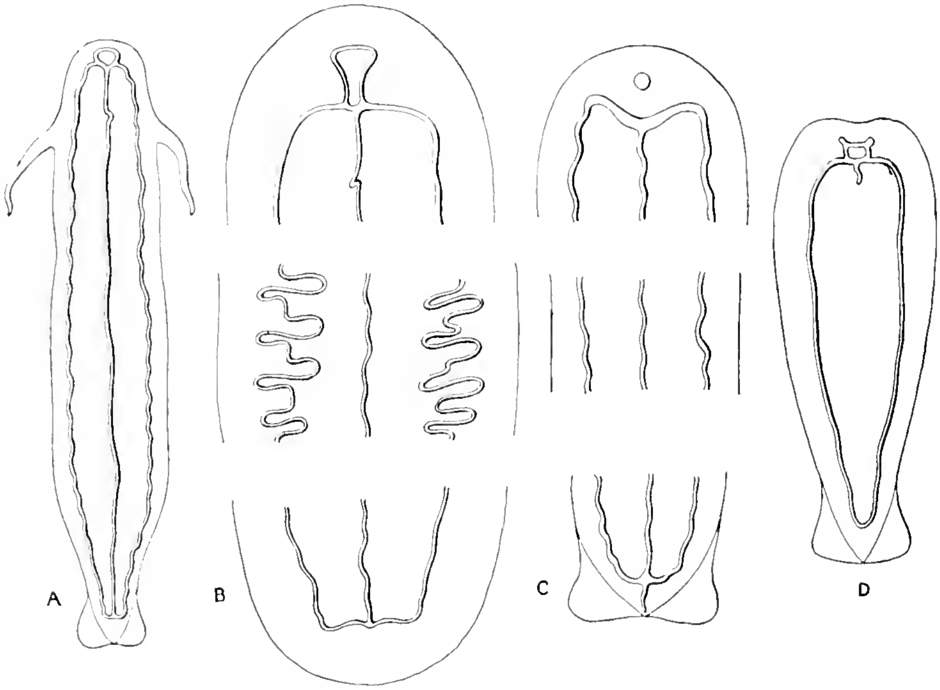


Fig. 25.— Diagrams of the vascular system in four families of pelagic nemerteans. A, *Nectonemertes pelagica* Cravens & Heath, showing a simple type with the three longitudinal vessels and three anastomoses. Point where dorsal vessel leaves the rhynchocoel indicated by the sharp bend. B, *Planktonemertes agassizii* Woodworth, showing the convolutions of the lateral vessels in the interdiverticular spaces. C, *Proarmaueria pellucida* Coe, showing the entire absence of a dorsal cephalic anastomosis, but with a compensating enlargement of the ventral anastomosis; at the posterior end of the body the posterior anastomosis is distended and from it leads a distinct caudal vessel. D, *Pelagonemertes brinkmanni* Coe, showing the rudimentary dorsal vessel and the evaginations of the dorsal cephalic anastomosis to form a pair of small lacunae.

At the posterior end of the body the lateral vessels are again united by a dorsal anastomosis which passes above the rectum in close proximity to the posterior commissure of the lateral nerves. The median dorsal vessel usually ends in this anastomosis.

The dorsal vessel in all families except Armaueriidae enters the rhynchocoel just posterior to the origin of the former from the ventral anastomosis, and in all except the Pelagonemertidae it leaves the rhynchocoel a short distance further posteriorly by passing obliquely through the ventral wall of the proboscis-sheath, beneath which it continues posteriorly. After reaching the posterior end of the sheath the dorsal vessel runs through the parenchyma beneath the dorsal body-wall to the posterior anastomosis of the lateral vessels (Figure 25).

In all members of the Pelagonemertidae the dorsal vessel is rudimentary and ends blindly, frequently in a bulb-like swelling, after extending posteriorly a short distance in the rhynchocoel (Figure 25). In *B. chuni*, however, this vessel is stated by Bürger ('09) to be entirely lacking.

In Armaueria and Proarmaueria, at present constituting the Armaueriidae, the vascular system differs from that of all the other known forms in that the anterior cephalic anastomosis is absent and the dorsal vessel extends to the posterior end of the body without entering the rhynchocoel (Figure 25). In this family also the dorsal vessel extends posteriorly beyond the posterior anastomosis as a more or less distinct caudal vessel (Plate **20**, fig. 121; Plate **22**, fig. 134, 135).

Lateral vessels. In the smaller and more slender forms the lateral vessels take a nearly straight or somewhat wavy course through the body, but in those species in which the worms are of medium or large size, these vessels exhibit numerous convolutions between the intestinal diverticula, whereby their length is increased much beyond that of the body itself. In *Planktonemertes agassizii*, for example, these vessels are provided with loops in the interdiverticular spaces whereby their length is increased to several times the body-length, but no branches are found (Figure 25). In some of the largest forms, moreover, particularly in species of Dinonemertes, the convolutions become greatly exaggerated in the females at the time of sexual maturity, twisting back and forth in the parenchyma surrounding the ovaries to such an extent that a single transverse section of the body may show a half-dozen or more sections of the single convoluted vessel. The special advantage of this enormous increase in the length of the vessel is that there is thus provided a much greater surface area for the transfer of nourishment and oxygen to the rapidly growing ovaries. In the young worms and in the males the vessels have relatively few loops.

Occasionally the lateral vessel may divide, in which case the two branches after winding about in the parenchyma for a short distance will again fuse into a single vessel. In no case, however, do metameric connections between the lateral vessels occur except for the anastomoses at the anterior and posterior ends of the body although, it will be remembered, such anastomosing vessels are usually found throughout the body in the littoral species. In a few instances rudimentary vessels have been found to leave the dorsal vessel, but these end blindly in the parenchyma after extending a short distance laterally. Brinkmann ('17a) describes one such case for *Armaueria rubra*.

Dorsal vessel. In addition to the usual relations of the dorsal and lateral vessels mentioned above there are a few exceptional cases in which interesting deviations from the typical conditions have been observed. Brinkmann ('17a) found a curious anomaly in one specimen of *Pendonemertes levinsini*, where the posterior anastomosis of the lateral and dorsal vessels was double on one side of the body. This suggests a vestigial condition of the ancestral metameric connections of the littoral nemerteans.

Another anomaly occurs in Planonemertes, where the dorsal vessel arises from the fusion of a pair of vessels instead of singly, as usual. The two constituent vessels fuse just anterior to the point where the vessel enters the rhynchocoel (Figure 26). After extending a distance of only 1.5 mm. in the rhynchocoel the dorsal vessel forms a bulb-like swelling, from the posterior end of which a slender vessel passes through the ventral wall of the proboscis-sheath, beneath which it proceeds to the posterior anastomosis as in other forms.

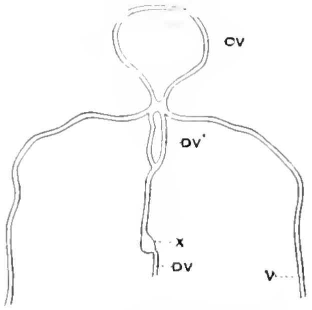


FIG. 26.—*Planonemertes lobata* Coe. Diagram of blood-vessels in anterior portion of body, showing the two roots (*dv'*) of the dorsal vessel, which unite just before entering the proboscis-sheath, the bulb (*x*) at the point where the dorsal vessel (*dv*) leaves the rhynchocoel, the lateral vessels (*v*), and the cephalic vessels (*cv*).

In *Dinonemertes investigatoris* the dorsal vessel shows the usual origin from the ventral cephalic commissure, but immediately enters the wall of the proboscis-sheath, in passing through which it divides into a plexus of smaller vessels separated by the muscular bundles of the sheath. On reaching the rhynchocoel the smaller vessels reunite to form the single dorsal vessel.

In the Pelagonemertidae, in which the dorsal vessel is rudimentary and ends blindly in the rhynchocoel, there are many variations in the extent to which the vessel is developed. Frequently this vessel pierces the ventral wall of the proboscis-sheath immediately after its origin from the ventral anastomosis of the lateral vessels and takes a position on the ventral side of the rhynchocoel immediately beneath the endothelial lining of the latter. After extending posteriorly in this position for a distance of a millimeter or less the vessel ends blindly, in some species tapering to a fine point but more frequently swelling into an irregular vesicle or bulb-like enlargement. The actual size and shape of the terminal portion doubtless depends in large measure on the state of contraction of the body, for the vessel may be either distended with blood or empty.

In some forms the dorsal vessel ends immediately after having reached the rhynchocoel; in several species of Pelagonemertes it extends in this cavity only a small fraction of a millimeter and in one species, *Balaenanemertes chuni* Bürger ('09), as has been stated, was unable to find the vessel at all.

Caudal vessel. In Pendonemertes and Plotonemertes the posterior anastomosis of the blood-vessels lies some little distance anterior to the posterior tip of the body and the dorsal vessel continues posteriorly beyond the posterior anastomosis. This gives rise to a short caudal vessel which ends blindly near the tip of the tail.

In one specimen of *Armaueria rubra* Brinkmann ('17a) found a distinct caudal vessel extending posteriorly from the posterior anastomosis of the lateral and dorsal vessels, and in several other genera, including Dinonemertes, indications of this vessel have been found. In *Proarmaueria pellucida* the caudal vessel is very conspicuous as a thin-walled tube extending along the dorsal wall of the rectum to the posterior extremity of the body (Plate 20, fig. 121; Plate 22, fig. 134, 135; Figure 31). The contraction of the body in each of the two specimens available for study was evidently such that the blood had been forced into the vessels at both ends of the body distending them to their full capacity, for the single cephalic anastomosis was similarly enlarged (Plate 20, fig. 121).

NERVOUS SYSTEM

The brain of the pelagic species differs from that of the littoral Drephanophoridae in that the dorsal ganglia in the former are usually no larger, and in many species are considerably smaller, than the ventral. The two ganglia of each side are closely fused together, and both dorsal and ventral commissures are well developed. Neurochord cells are absent in all species, but the three other types of ganglion-cells found in littoral forms are present. Frequently the brain and in some cases the lateral nerves of such species as have been seen in life contain a bright red pigment in solution. In this respect the pelagic nemerteans agree with many littoral forms where the color has been shown to be due to a compound allied to hemoglobin.

The brain is usually surrounded and widely separated from the muscular walls of the head by a great mass of gelatinous tissue, but in a few forms such as *Cuneonemertes gracilis*, in which the cephalic parenchyma is much reduced, the space between brain and cephalic walls is much reduced (Plate **24**, fig. 145). Only in Paradinonemertes, in which the mouth opens behind the commissures, is the brain situated close against the ventral cephalic walls; in all the other genera the oesophagus or stomach passes beneath the brain, keeping it well separated from the ventral walls of the head.

Cephalic nerves. A considerable number of nerves of various sizes originate from the anterior surfaces of both ventral and dorsal ganglia and others from the dorsal surface of the latter to supply the muscles, integument, and sense-organs of the head. Even the smaller of these nerves are frequently conspicuous in the stained sections and are easily followed as they pass through the thick mass of gelatinous parenchyma surrounding the brain. Most of them branch repeatedly so that a single transverse section shows sections of very numerous branches (Plate **10**, fig. 66, 67). Although many of the cephalic nerves are of rather large size they are as a rule smaller and less numerous than in the littoral species which are provided with ocelli and other well-developed sense-organs. They have about the same origin and distribution as in littoral species, some of their largest branches supplying the sense-organs in and beneath the integument (Figure 27).

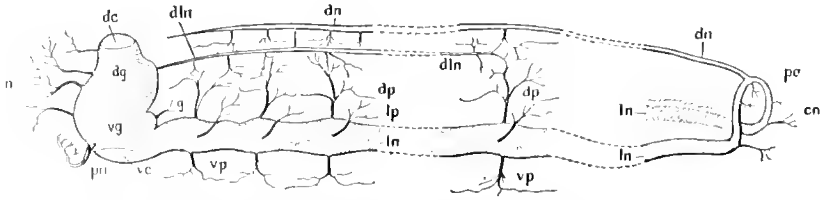


FIG. 27.— Diagram of nervous system of *Neuronemertes aurantiaca* Coe, showing dorsal (*dg*) and ventral ganglia (*vg*), with the corresponding commissures (*dc*, *vc*), cephalic nerves (*n*), origin of proboscidial nerves (*pn*), dorsal nerve (*dn*) entering the posterior anastomosis (*pa*) of the lateral nerves at the caudal extremity but terminating anteriorly some distance behind brain; *ln*, lateral nerve, with metameric dorsal (*dp*), lateral (*lp*) and ventral peripheral nerves (*vp*); *dln*, dorsolateral nerve, with delicate communicating branches both with the dorsal nerve and with the dorsal peripheral branches of the lateral nerve; *g*, gastric nerve; *cn*, caudal nerves.

Proboscidial nerves. These nerves commonly arise, as in many littoral nemerteans, as a single pair from the medial side of the brain at the point where the commissure joins the ventral ganglia. This pair of large nerves divides into the definitive proboscidial nerves either at the attachment of the proboscis or in this organ immediately behind its insertion. This is conspicuously the condition in Nectonemertes, as described by Cravens and Heath ('07), where the proboscis is attached well in front of the brain, but in other forms, as Planktonemertes and Balaenanemertes, where the proboscis is inserted close in front of the brain, the proboscidial nerves either arise in their complete number from the ganglia and the commissure adjacent or branch immediately after their origin.

After entering the muscular wall of the proboscis the proboscidial nerves divide immediately into their definite number in case such division did not occur between the brain and the proboscis-insertion. As shown in Plate **4**, fig. 29–32, the nerves take up a position in the midst of the longitudinal muscular layer along the whole circumference of the proboscis. This position varies somewhat in the different forms, but is generally about two thirds the distance from the inner to the outer border of the longitudinal muscular layer. Here the nerves branch out to form a thick plexus of connecting fibers and send symmetrical branches radially both towards the periphery and towards the central lumen (Plate **4**, fig. 29–32).

About midway between each two proboscidial nerves in certain species the plexus is condensed into a secondary nerve, commonly about half the diameter of each of the main nerves (Plate **4**, fig. 32). There is thus an equal number of primary and secondary nerves in such species as *Planktonemertes agassizii*, *Plionemertes plana*, and *Pelagonemertes joubini*. In some forms it is difficult to distinguish the two sets of nerves, so that one specimen may appear to have double the number found in other specimens where the proboscis is in a different state of contraction.

Furthermore in some forms, as *Armaueria rubra*, for example, the number of nerves in the anterior end of the proboscis may be double that found farther back toward the stylet-region, due to the gradual disappearance of each alternate, or secondary, nerve in the plexus. And, finally, the number may vary to some extent in different individuals, as in *Nectonemertes mirabilis* where the number ranges from eighteen to twenty-four.

The central radial branches from the nerve-plexus pass between the bundles of longitudinal muscles and form a second, delicate intermuscular plexus beneath the inner circular muscles. From this plexus fine nerve-fibers supply the epithelium of the papillae as well as the inner circular muscles.

The peripheral radial branches arising from each of the primary nerves (Plate **4**, fig. 32) form a third, still more delicate, plexus between the longitudinal muscles and the outer circular muscular layer. This supplies in a similar manner the more superficial layers of the proboscis, namely, the outer circular muscles and the endothelium.

There are thus formed three nervous plexuses, middle, inner, and outer, of which the two latter are of great delicacy and can be observed only under favorable conditions of preservation, and it is by no means certain that they are present in all species.

The radial nerves leave the middle plexus only at intervals, but the three plexuses appear to form more or less continuous networks throughout the length of the anterior chamber. In some forms even the middle plexus is incompletely developed, the primary proboscidial nerves being connected with each other only at intervals.

In the middle chamber the plexuses are interrupted by the interlacing of the muscular layers, and the primary nerves gradually lose their identity in a multitude of smaller branches (Plate **4**, fig. 31), some of which innervate the stylet musculature and gland-cells, while others continue backward into the wall of the posterior chamber.

Hence in the posterior chamber the primary nerves are not usually distinguishable as separate units and there is but a single plexus lying between the longitudinal muscles and the glandular epithelium-lining of the lumen.

The number of proboscidial nerves in the various pelagic species as far as determined at present is as follows: — *Protopelagonemertes hubrechti*, 29; *Plotonemertes adhaerens*, 27; *Pendonemertes levinsini*, 16 (23); *Planktonemertes agassizii*, 25 (50); *P. vanhöffeni*, 24; *Crassonemertes robusta*, 20, 21; *Bürgeriella notabilis*, 21; *Paradinonemertes drygalskii*, 13; *Dinonemertes investigatoris*, 30 or more; *D. alberti*, 28; *Plionemertes plana*, 24 (43–48); *Nectonemertes mirabilis*, 18–24; *N. minima*, 18; *N. pelagica*, 18, 19; *N. japonica*, 22; *Phallonemertes murrayi*, 15–17; *Chuniella lanceolata*, 21; *C. pelagica*, 24; *Armaueria rubra*, 14 (7); *Proarmaueria pellucida*, 10 (14); *Cuneonemertes gracilis*, 12; *Natonemertes acutocaudata*, 12, 13; *Parabalaenanemertes fusca*, 12; *Balaenanemertes lobata*, 17, 18; *B. musculocaudata* 17, 18; *B. grandis*, 16; *B. chuni*, 14 (16); *Pelagonemertes rollestoni*, 16; *P. brinkmanni*, 19; *P. joubini*, 15 (30).

Lateral nerves. In the vast majority of pelagic forms fibers from both dorsal and ventral ganglia continue posteriorly into the fibrous cores of the lateral nerves. In such cases a transverse section of the nerve-cord frequently shows two distinct fibrous cores separated by a layer of ganglion-cells (Plate **13**, fig. 89; Figure 29). One of these cores usually occupies the dorsal side of the cord, while the other is situated ventrally. The dorsal core, arising from the corresponding ganglion, is much smaller than the ventral and its separation from the latter tends to become less distinct in the posterior half of the body. Toward the posterior end of the body this core becomes gradually smaller, only the fibers of the ventral core being involved in the posterior nerve-commissure. Occasionally the core from the dorsal ganglion tends to occupy the lateral rather then the dorsal side of the nerve-cord.

In some species the ventral ganglia merge so gradually into the lateral nerves that no point of demarcation between brain and nerves can be determined (Figure 28).

In a few genera, as Planktonemertes, Pendonemertes, Plionemertes, and Crassonemertes, there is but a single fibrous core and this arises mainly from the ventral ganglion. It presumably also contains fibers from the dorsal ganglion although they are not visibly separated from the others (Plate **13**, fig. 90, 91; Figure 29).

In Chuniella there is found a condition intermediate between those forms having a single fibrous core and those with distinctly separated dorsal and ventral cores, for in *C. lanceolata* there is a small dorsal core separated from the ventral core in the anterior half of the body only. In *C. pelagica* only a single core was found by Bürger ('09). In Proarmaueria the dorsal core is small and is separated from the ventral core by a single layer of ganglion-cells in the anterior half of the body (Plate **21**, fig. 132; Figure 29). Posteriorly the separation disappears, although the more delicate dorsal fibers can be distinguished for some distance farther back (Plate **21**, fig. 131).

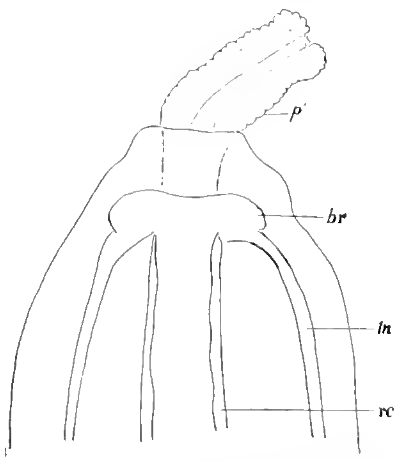


Fig. 28.—*Nectonemertes pelagica* Cravens & Heath. Anterior end of body of female, showing position of brain (*br*) and lateral nerves (*ln*); *p*, *p'*, proboscis; *rc*, rhynchocoel.

The position which the lateral nerves occupy in the body varies greatly according to the degree of development of lateral margins. In those forms in which the body is but little flattened, as in Cuneonemertes, Nectonemertes, and Chuniella, the nerve-cords lie near the lateral margins of the body, but in the broad, flattened forms, as Dinonemertes, Planktonemertes, and Planonemertes they are far removed from the lateral margins, being in some cases situated more than half-way toward the median line. In nearly all species the nerve-cords bend more or less sharply laterally immediately after their origin from the brain. In most forms they lie in the parenchyma near the ventral surface of the body, but in those cases, as Neuronemertes, Planktonemertes, Crassonemertes, and Plotonemertes, where a large ventral branch from the intestinal diverticulum forces its way beneath the nerve-cord, the latter is moved dorsally until it may lie about midway between dorsal and ventral surfaces.

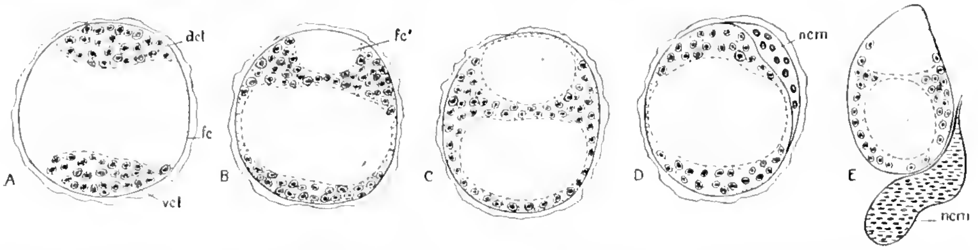


FIG. 29.— Diagrams of transverse sections of the lateral nerve-cords in five genera of pelagic nemerteans, showing the relation of the fibrous cores to the cellular layers. A, *Plionemertes plana* Coe, with single fibrous core (*fc*) and symmetrical dorsal and ventral cellular layers (*dcl*, *vcl*). B, *Proarmaueria pellucida* Coe, with minute dorsal core (*fc'*). C, *Planonemertes lobata* Coe, with large dorsal core. D, *Cuneonemertes gracilis* Coe, with single fibrous core and thin band of nerve-cord muscle (*ncm*). E, *Balaenanemertes chuni* Bürger, with double fibrous core and very large nerve-cord muscle (*ncm*).

Near the posterior end of the body the two lateral nerves are connected by a well-marked commissure which passes on the dorsal side of the posterior end of the intestine or rectum. This is accompanied by the anastomosis of the lateral blood-vessels (Plate **16**, fig. 103; Figure 30), sometimes the one and sometimes the other lying more anteriorly.

The nerve-cord muscles which accompany the lateral nerves in most of the Armaueriidae and Pelagonemertidae, and which is especially massive in Pendonemertes, are described in the chapter on the muscular systems.

Peripheral nerves. Plate **13**, fig. 89, 90, as well as Figure 27, show the three peripheral nerves which leave the nerve-cord in each of the interdiverticular spaces. The dorsal and ventral peripheral nerves (*dp*, *vp*) are both large, while the lateral (*lp*) is much smaller and appears in some cases to arise, not from the cord itself, but as a branch of the dorsal peripheral nerve. These nerves can be followed in some sections almost as clearly as if they were actually dissected out, for they have fortunately taken a deep orange stain, while the parenchyma is bluish (Plate **4**, fig. 33; Figure 3).

The dorsal peripheral originates from the dorsal fibrous core close against the lateral border of the blood-vessel. In fact, the blood-vessel is constricted and deflected medially as it passes this nerve-root. Immediately after its origin this nerve bends medially, then dorsally and divides into three main branches.

One of these branches runs dorsomedially to supply the region of the proboscis-sheath and then joins with the dorsolateral nerve to enter the intermuscular plexus. Some of the branches of this nerve enter the proboscis-sheath; others end in the adjacent bundles of dorsoventral muscles. The middle and lateral branches of the dorsal peripheral nerve supply the dorsolateral portions of the body-walls, sending branches both into the intermuscular plexus and into the adjacent dorsoventral muscles (Plate **4**, fig. 33).

The lateral peripheral is a slender nerve which originates at the apex of the cellular mass separating the dorsal and ventral cores of the cord. It runs with few branches to the lateral margin of the body, and appears also to enter the intermuscular plexus.

The ventral peripheral (Plate **13**, fig. 89, 90) originates from the ventral core of the cord, passes first laterally and then bends sharply ventrally, after which it divides into two branches which supply the ventral portions of the body. Branches from this nerve enter the ventral intermuscular plexus (Plate **4**, fig. 33).

Intermuscular plexus. In some of the sections of *Neuronemertes aurantiaca* distinct nerves can be seen leading from the dorsal nerve inward through the circular muscular layer and thence laterally between the two muscular layers of the body-walls. These nerves appear to constitute part of a great plexus of nerve-fibers which extends between the circular and longitudinal musculatures throughout the length of the body. The plexus is in frequent communication with the peripheral nerves from the lateral cords, as well as with the dorsal and dorsolateral nerves. Very few nerve-cells are found in the plexus itself, but it is quite possible that the ganglionic masses

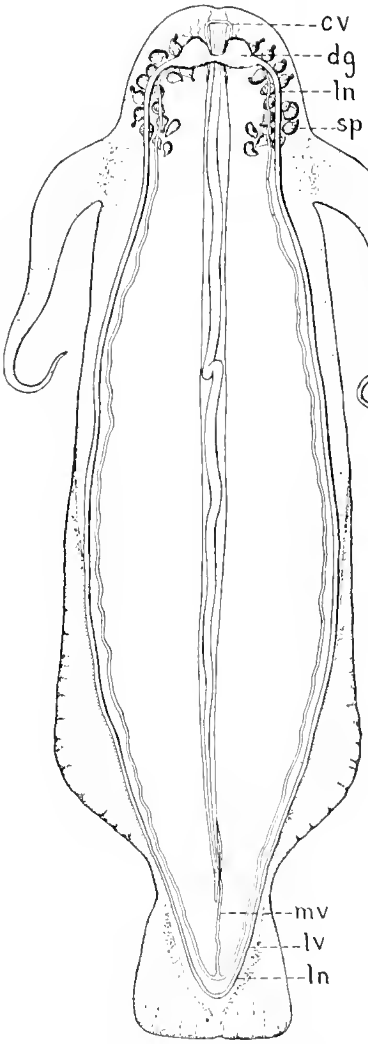


FIG. 30.— *Nectonemertes mirabilis* Verrill. Outline of body from ventral surface, showing nervous, vascular, and reproductive systems; *cv*, cephalic vessels; *dg*, dorsal ganglion; *ln*, lateral nerve; *lv*, lateral vessel; *mv*, median dorsal vessel; *sp*, spermaries.

so conspicuous beneath the dorsal nerve contain the cell-bodies from which the fibers of the plexus originate (Plate **11**, fig. 73–78).

A delicate submuscular plexus connected with the peripheral nerves can be demonstrated (Plate **11**, fig. 73–78; Figure 31).

Dorsal nerve. This nerve is well developed in nearly all species. It lies imbedded in the parenchyma just external to the circular muscular layer and in the median axis of the body. In Neuronemertes and many of the other pelagic forms, it may be followed to the posterior end of the body, where it enters the posterior anastomosis of the lateral nerves. This nerve appears not to be connected with the brain, but becomes smaller in its anterior portion and ends freely in the cephalic parenchyma, not far posterior to the dorsal commissure (Figure 27). In *Planktonemertes vanhoeffeni*, Brinkmann ('17a) followed this nerve anterior to the brain, but without finding any connection with the latter, but in other genera it becomes very slender anteriorly and terminates some distance posterior to the brain, disappearing in the delicate intermuscular plexus.

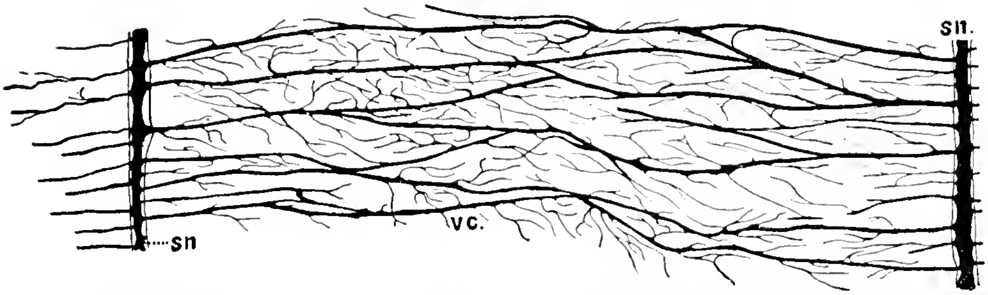


Fig. 31.—*Dinonemertes alberti* (Joubin). Diagram of network of nerves (*vc*) connecting the lateral nerves (*sn*) beneath the intestine. (After Brinkmann, 1917a).

The remarkable development of the dorsal nerve and its accompanying problematical organs in *Neuronemertes aurantiaca* is fully described in the systematic account of that species (p. 129, 130).

Dorsolateral nerves. In the anterior part of the body of many of the pelagic nemerteans there is a pair of conspicuous nerves situated just internal to the body-musculature on either side of the proboscis-sheath (Figure 27). These evidently correspond to the dorsolateral nerves of other platyhelminths. They are found also in Drepanophorus and Uniporus, but are quite distinct from the inner dorsal, or subdorsal, nerve of Carinoma and other mesonemerteans. Hence to avoid confusion the term "dorsolateral" appears preferable to "subdorsal." These nerves originate from the posterior borders of the dorsal ganglia and extend posteriorly in the angles between the dorsolateral border of the proboscis-sheath and the musculature of the body-wall (Plate **4**, fig. 33; Plate **10**, fig. 68), as described for *Planktonemertes agassizii* and for *Neuronemertes aurantiaca*. In *Dinonemertes alberti* there are two of these nerves on each side, but they are connected by communicating fibers, and in Phallonemertes each of them arises as two roots from the dorsal ganglion.

The dorsolateral nerves supply the dorsal musculature of the body-walls for a short distance posterior to the brain, and in Neuronemertes, at least, appear to control the dorsoventral musculature which in that genus is so strongly developed in the immediate vicinity of the spermaries. Through communicating branches they appear to aid also in the innervation of the proboscis-sheath, and in Phallonemertes they extend backward nearly to the end of the proboscis-sheath. They are connected with branches both from the dorsal nerve and from the dorsal peripheral branches of the lateral nerves (Figure 27).

Anteriorly the dorsolateral nerves lie free in the parenchyma just internal to the body-musculature, but toward their posterior ends they become intimately associated with the inner border of the longitudinal muscular layer, and eventually terminate in communicating branches of peripheral and dorsal nerves (Plate **4**, fig. 33; Figure 27).

Caudal nerves. In most pelagic nemerteans the posterior ends of the lateral nerves pass directly into the commissure on the dorsal side of the rectum, but occasionally, as in *Proarmaueria pellucida*, they each divide into two branches. The dorsal branch forms the commissure while a smaller, ventral branch continues posteriorly close beside the rectum to supply the posterior end of the caudal region (Plate **22**, fig. 134).

In the other forms the extreme caudal end of the body appears to be supplied with small nerves from the commissures (Figure 27).

Gastric nerves. There has been observed in several pelagic species a pair of nerves homologous with oesophageal nerves in the littoral forms and like them arising from the posterior border of the ventral ganglia (Figure 27). Since the oesophagus is rudimentary in pelagic nemerteans these nerves are distributed to the stomach. In Bürgeriella these nerves are very small, the principal nerve-supply to the stomach being provided by a second pair of nerves arising from the ventral commissure.

Pyloric nerves. In Cuneonemertes a small branch from one of the peripheral nerves enters each anteriolateral border of the pylorus.

Proboscis-sheath nerves. In most forms nerve-fibers enter the proboscis-sheath at the ring of the proboscis-insertion, but in Cuneonemertes a supplementary supply is provided by a pair of branches from the peripheral nerves which enter the sheath at the point where the nerve-cord muscle originates.

SENSE-ORGANS

Even the most primitive of the littoral nemerteans are provided with special sense-organs as differentiated portions of the integument, and in the higher groups ocelli, cerebral sense-organs, and frontal sense-organs are of frequent occurrence. In addition, otocysts are found in a few species. But in the pelagic forms no such organs are present in any of the species studied up to this time. This is the more remarkable in as much as ocelli and cerebral sense-organs are so highly developed in their supposedly nearest littoral relatives, the Drepanophoridae. Possibly vestiges of one of these types of sense-organs were discovered by Bürger ('09) in Balaenanemertes. These are considered by him to be rudimentary ocelli and similar organs were shortly afterward found by Brinkmann in *Pelagonemertes rollestoni.* Further studies have shown them to be widely distributed among the Armaueriidae and Pelagonemertidae.

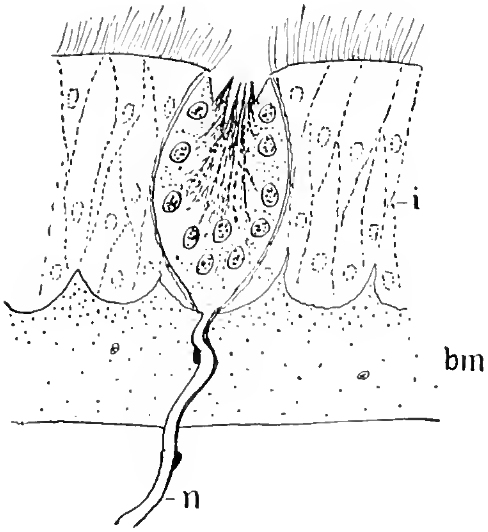


FIG. 32.— Diagram of integumentary sense-organ in *Cuneonemertes gracilis* Coe, with its nerve (*n*) leading to dorsal ganglion.

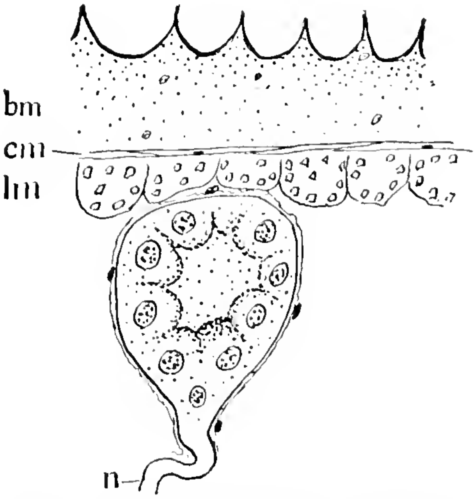


FIG. 33.— Diagram of sense-organ beneath the cephalic wall of *Cuneonemertes gracilis* Coe, with nerve (*n*) leading to dorsal ganglion.

In these forms a small cluster of these subcutaneous sense-organs, whatever their nature may be, is situated beneath the basement-layer of the anterior margin of the head, frequently on either side of the rhynchodeal opening. Each of the end-organs consists of a pear-shaped group of cells, connected with a branch of one of the cephalic nerves. Some of them lie in contact with the inner border of the basement-layer, while others may be situated somewhat deeper in the cephalic tissues, and in or even beneath the muscular layers (Figure 33). Neither the arrangement of the cells which make up the organ nor the relation of the nerve to the component cells is at all similar to the conditions which are found in the nemertean ocellus. It therefore seems quite possible that these are special sense-organs peculiar to the pelagic forms rather than that they represent degenerate ocelli.

Integumentary sense-organs. A second type of sense-organ occurs in the integument of the head and less frequently in other parts of the body in Nectonemertes and certain other genera. These consist of compact groups of sensory cells imbedded in the integument. The cells are provided with slender distal processes and each group is supplied with a nerve leading to the brain or to the lateral nerve, according to its location (Figure 32). It is not improbable that such integumentary sense-organs occur in the majority of the pelagic species, but that the loss of the integument during capture has prevented their discovery. Brinkmann ('17a) states that they are not present in the Protopelagonemertidae nor in the species of Dinonemertes which he studied. They are well developed in Cuneonemertes.

PROBLEMATICAL ORGANS

The single specimen of *Neuronemertes aurantiaca*, described in this report as a new genus and species, was provided with a row of peculiar metameric organs along the median line of the body and on the ventral side of the dorsal nerve. Whether these organs are modifications of the nervous system, as secondary nerve-centers or ganglia; whether they are sense-organs peculiar to this genus, or whether they may possibly be light-producing organs could not be determined.

These organs are described in detail in the discussion of the species in which they occur and are illustrated on Plate 11, fig. 73–78. The depth at which the individual lived did not exceed 300 fathoms, for it was taken in the trawl towed at that depth and then brought vertically to surface. The specimen may have been caught during the upward course of the trawl, but the probabilities are that it lived far beneath the surface. Since phosphorescent organs are known to occur in such a wide diversity of invertebrate phyla, it is not incredible that the organs under discussion are of a similar nature. Perhaps they may be rather light-perception organs, or ocelli, but if so they have a totally different structure than the ocelli of other forms. Their lack of direct communication with the surrounding water precludes the possibility that they have a chemical sense, such as is inferred for the cerebral sense-organs, which are missing in all bathypelagic forms.

Adhesive organ. In *Plotonemertes adhaerens* Brinkmann ('17, '17a) found a pair of peculiar glandular structures on the ventral surface near the posterior end of the body. These organs are semicircular folds of the integument about 1.75 mm. long by 2.75 mm. wide, leading posteriorly beneath the surface into a blind glandular pouch (Figure 54, 55). It is not known whether they occur in both sexes, for as yet only the male of this species has been discovered. It is suggested, however, that they may aid the male in adhering to the female during the time of sexual maturity, the sperm being liberated coincident with the discharge of ova. A high percentage of fertilization would thus be assured.

Reproduction

In all the known forms of pelagic nemerteans, with the exception of the partially hermaphroditic *Proarmaueria pellucida* and an occasional hermaphroditic gonad in one or two other forms, the sexes are separate and the reproductive organs greatly modified from the primitive condition which holds for the littoral species. This is true not only for the position and structure of the gonads, but for the efferent ducts and, in the case of the female, for the sexual products themselves.

In most forms the sexes are readily distinguished by the position of the gonads, for in all pelagic forms the spermaries are in or near the head, while the ovaries retain their primitive positions between the intestinal diverticula. The number of ovaries is as a rule much less than in littoral species of about the same size, and the number of eggs produced is very limited.

In Nectonemertes, moreover, the sexes are differentiated by an even more conspicuous feature, namely, the presence in the adult males of a pair of slender muscular outgrowths from the body-walls back of the head. In some of the species of this genus these appendages develop into lash-like, muscular, highly contractile tentacles which may reach a length of two to three or more times the diameter of the body. (Figure 8, 30, 84, 87, 90).

Sexual dimorphism. Some of the pelagic nemerteans exhibit a true sexual dimorphism, the sexes when adult differing so widely in appearance as to appear to belong to entirely different genera. Indeed it is but recently that the females of Nectonemertes have been recognized as belonging to that genus, all earlier investigators, including Verrill, the discoverer of the type species ('92) and

Bürger, who studied the anatomical details of both sexes ('09), having assigned the females to a separate genus, Hyalonemertes.

Brinkmann ('12) first called attention to the fact that in *Nectonemertes mirabilis* the tentacles became fully developed in the males only at the approach of sexual maturity, the young males having only rudimentary appendages. The other species of the genus, *N. pelagica*, *N. minima*, and *N. primitiva* have a similar sexual differentiation. The female of *N. japonica* is still unknown.

Probably the reasons why this sexual dimorphism was not discovered earlier were, first, that but few specimens were available for study and, secondly, that in two of the species only the males had been discovered when the species was described.

Verrill ('92) described various growth-stages of the tentacles in *Nectonemertes mirabilis*, and Brinkmann in his report on the collections of the Michael Sars expedition ('17) and also in his great monograph on the pelagic nemerteans ('17a) has explained in much detail the sexual dimorphism of this species. The latter investigator had for study by far the most extensive collections of pelagic nemerteans that have ever been brought together. His material contained no less than one hundred and sixteen specimens of *Nectonemertes mirabilis* from various stations in the North Atlantic Ocean between 34° and 64° N. Lat. The total number of specimens previously known was only ten, eight of which were males.

Of the one hundred and sixteen specimens studied by Brinkmann, thirty-two were provided with more or less well-developed tentacles and with the cephalic gonads characteristic of the males, while eighty-four were without these appendages. Of the latter, sixty-three were easily recognized as females, while the remaining twenty-one specimens were all small and needed more careful examination to determine the sex. Six of them proved to be young males with the spermaries in an early stage of development, but the other fifteen were quite immature and appeared to be sexually undifferentiated.

The size of the tentacles in the males sufficiently mature to develop these appendages varied from slight traces of elevations of the body-walls on the sides of the head to a length of 10 mm. The developmental stages of these organs form a graded series perfectly correlated with the state of maturity of the spermaries (Figure 8).

A worm in the first stage, for example, with a body-length of about 21 mm. had but slight indications of the tentacles. In this stage the spermaries consisted simply of thin-walled sacs, without other sexual elements than the primitive spermatogonia merely imbedded in the walls. The musculature was represented merely by scattered nuclei imbedded in a more or less continuous protoplasmic mass, the whole being covered by a delicate sheet of connective tissue (Figure 8, *a*).

In the second stage, when the projections which are to form the tentacles have reached an elevation of about one millimeter, the cells which are to form the musculature have assumed a peripheral position surrounding the more numerous spermatogonia. At this stage also the first spermatocytes appear.

A worm in the third stage measured about 34 mm. in length, with tentacles 4 mm. long. The spermaries are here provided with a well-developed musculature and the processes of spermatogenesis have progressed to the stage where the spermatids are formed, and in some cases the unripe spermatozoa are imbedded in their cytophores. The sexual cells have multiplied to such an extent that they fill up most of the lumen of the spermary.

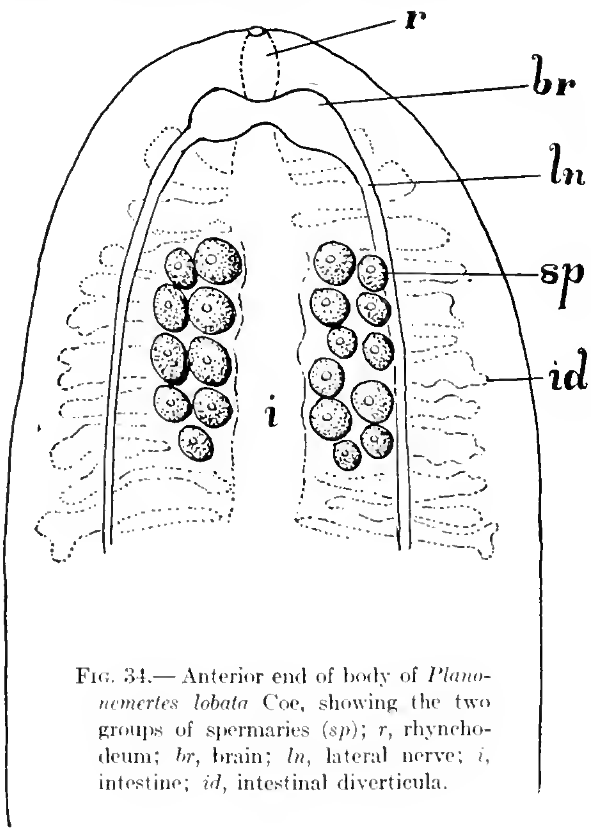


Fig. 34.—Anterior end of body of *Planonemertes lobata* Coe, showing the two groups of spermaries (*sp*); *r*, rhynchodeum; *br*, brain; *ln*, lateral nerve; *i*, intestine; *id*, intestinal diverticula.

In full sexual maturity, which may occur with a body-length of about 40 mm., the tentacles are fully formed and reach a length of 6 mm. or more. The spermatogonia have now mostly disappeared in the formation of spermatocytes, and the spermaries are filled with spermatocytes, spermatids, and spermatozoa in various stages of maturity. Brinkmann ('12, '17, '17a) considers that these peculiar appendages have become specialized to serve not only as an aid in swimming but also as grasping organs by which the male is able to cling to the female during the act of insemination. It seems very probable that this interpretation is correct. Living as the worms do in the vast areas of the deep sea and not limited as are so many other forms to a relatively confined volume of water, there must be a conservation of the genital products so as to assure the greatest chance of fertilization. The scattering of a multitude of eggs and sperm in the depths of the ocean would result in relatively few offspring, for there would be few chances of any sperm meeting an egg in the vast areas through which the individuals are so sparsely distributed. The survival of the species, therefore, depends upon the development of special adaptive features and instincts of such a nature that an actual pairing of individuals will occur when mature worms of the two sexes meet, thus assuring the fertilization of the eggs produced. For such purposes the tentacles of the males are very well adapted.

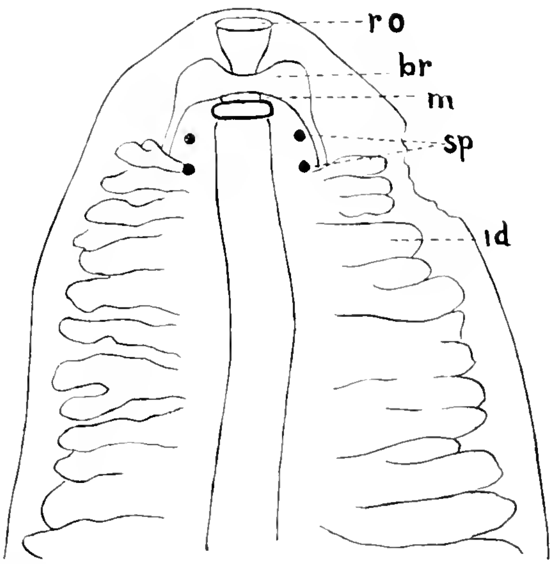


FIG. 35.—*Paradinonemertes drygalskii* Brinkmann. Outline of anterior end of body from ventral surface, showing the mouth (*m*) opening behind the brain (*br*), the terminal rhynchodeal opening (*ro*), the outlines of the intestinal diverticula (*id*) and the two pairs of spermaries (*sp*). (After Brinkmann).

In the majority of the bathypelagic species the spermaries are situated in the head, beside and immediately behind the brain. In other forms, as Pelagonemertes, however, they lie in front of the brain, sometimes close to the anterior border of the head (Figure 44, 47), while in Planonemertes (Figure 34), Dinonemertes (Figure 38), Paradinonemertes (Figure 35), and Phallonemertes (Figure 36) they are situated immediately posterior to the brain. In Pelagonemertes and Balaenanemertes they are grouped in a dense cluster on each side, while in most of the other genera they are arranged in elongated groups or in paired rows.

The number of spermaries found in *Nectonemertes pelagica* is twenty-one to twenty-three. These are arranged in an irregular elongated cluster on each side of the brain (Figure 84). *N. mirabilis* has eleven to twenty-four pairs, similarly placed (Figure 42); *N. minima* has only five, six, or seven spermaries on each side, and these are in a single row (Figure 87), while *N. primitiva* has the number reduced to four in a single row upon each side of the head (Figure 91).

Planonemertes lobata has nine to eleven spherical spermaries in a double row on each side of the body immediately behind the brain and not far from the median line (Figure 34).

In Dinonemertes the spermaries are in the same position as in Planonemertes in the only two species (*D. investigatoris* and *D. alberti*) in which the males have been described.

The following table will indicate the sexual conditions of the various species so far as known at present: —

TABLE SHOWING NUMBER AND POSITION OF THE GONADS IN SO FAR AS KNOWN FOR EACH SPECIES.

	Sex described	Position of spermaries (on each side)	Number of spermaries (on each side)	Number of ovaries (on each side)	Number of intestinal diverticula (on each side)
1 *Protopelagonemertes hubrechti*	Female	?	?	Many	Ca. 40
2 *Plotonemertes adhaerens*	Male	Single row (Beside and behind brain)	8–11	?	50+
3 *Pendonemertes levinsini*	Female	?	?	20–24	30–40
4 *Planktonemertes agassizii*	Female	?	?	15–30	40+
5 *P. vanhöffeni*	Female	?	?	14	Many
6 *Mononemertes sargassicola*	Female?	?	?	?	?
7 *Crassonemertes robusta*	Female	?	?	Ca. 35	Ca. 40
8 *C(?) rhomboidalis*	Female	?	?	?	?
9 *Mergonemertes woodworthii*	Female	?	?	7–8(?)	Many
10 *Neuronemertes aurantiaca*	Male	Single row (Behind brain)	10	?	Ca. 30
11 *Bürgeriella notabilis*	Male	Elongated group (Behind brain)	6	?	Few
12 *Paradinonemertes drygalskii*	Male	Single row (Behind brain)	2	?	40–50
13 *Dinonemertes investigatoris*	Female	?	?	42–50	63–70
14 *D. alberti*	Both	Elongated group (Behind brain)	6–8?	18–25	Ca. 50
15 *D. grimaldii*	Female	?	?	14–15	Many
16 *D. mollis*	Female	?	?	Ca. 30	Ca. 40
17 *Planonemertes lobata*	Male	Double row (Behind brain)	9–11	?	40–50
18 *Pelonemertes plana*	Female	?	?	Ca. 20	Ca. 32
19 *Phallonemertes murrayi*	Both	Single row (Behind brain)	4–7	24–29	40–50
20 *Chuniella lanceolata*	Male	Elongated group (Behind brain)	12–19	?	Ca. 30
21 *C. agassizii*	Female	?	?	Many	Ca. 50
22 *C. pelagica*	Female	?	?	12+(?)	Many
23 *C.(?) elongata*	?	?	?	?	Many

	Sex described	Position of spermaries (on each side)	Number of spermaries (on each side)	Number of ovaries (on each side)	Number of intestinal diverticula (on each side)
24 *Nectonemertes mirabilis*	Both	Elongated group (Beside and behind brain)	11–24	20–30	Ca. 50–60
25 *N. japonica*	Male	“	Ca. 19	?	Many
26 *N. pelagica*	Both	“	21–23	20–24	Ca. 50
27 *N. minima*	Both	Single row (Behind brain)	6–7	Ca. 25	Ca. 60
28 *N. primitiva*	Both	Single row (Beneath and behind brain)	4	10	Ca. 50
29 *Armaueria rubra*	Both	Single row (Behind brain)	8–12	8	Ca. 25
30 *Proarmaueria pellucida*	Male[1]	Double row	12–20	?	Ca. 18
31 *Cuneonemertes gracilis*	Female	?	?	9–10	11
32 *Natonemertes acutocaudata*	Male	Cluster (Behind brain)	4–5	?	15–20
33 *Pelagonemertes rollestoni*	Both	Cluster (Front of brain)	5–8	5–13	12–16(25?)
34 *P. joubini*	Female	?	?	18–20	18–25
35 *P. moseleyi*	Female	?	?	7–8	4
36 *P. brinkmanni*	Both	Cluster (Front of brain)	5–7	6–8	4–6
37 *Gelanemertes richardi*	Male	Single row (Front of brain	5	?	20+
38 *Parabalaenanemertes fusca*	Both	Cluster (Front and beside brain)	3–5	10	Ca. 15
39 *P.(?) zonata*	Female	?	?	Ca. 12	Few (?)
40 *Probalaenanemertes wijnhoffi*	Female	?	?	8–9	Ca. 15
41 *Balaenanemertes chuni*	Male	Cluster (Beside brain)	5	?	Ca. 11
42 *B. musculocaudata*	Male	Cluster (Front and beside brain)	6–8	?	Ca. 20
43 *B. lobata*	Both	(Beside brain)	?	7–8	17–22
44 *B. chavesi*	Male	Cluster (Beside brain)	?	?	Ca. 30–36
45 *B. grandis*	Male	Cluster (Beside brain)	4–7	?	Ca. 20
46 *B. hjorti*	Male	Cluster (Beside brain)	7–8	?	?
47 *B. lata*	Male	Cluster (Front and beside brain)	—	?	?

Inspection of the above table will show how incomplete is the present knowledge concerning these pelagic worms, for in only eleven of the forty-seven species have both sexes been discovered, and of the vast majority of the species only a single specimen has been studied. Of those species in which only one sex is known eighteen are represented by the female only and sixteen by the male alone. The descriptions of the two remaining species leave the sex undetermined. In one species, *Proarmaueria pellucida*, hermaphroditic glands occur in addition to spermaries.

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[1] Irregularly hermaphroditic.

Curiously enough, of the seven species of Balaenanemertes in which both sexes presumably have tentacles, the female of but one species, *B. lobata* has been discovered. In none of the species of Protopelagonemertes, Pendonemertes, Planktonemertes, Crassonemertes, Mergonemertes, Plionemertes, Cuneonemertes, or Probalaenanemertes has the male as yet been found, and this is true of the female in all species of Plotonemertes, Neuronemertes, Bürgeriella, Paradinonemertes, Planonemertes, Natonemertes, and Gelanemertes.

Just enough information is available to show that there exists far beneath the surface of the ocean a great diversity of these highly specialized nemerteans. In the North Atlantic, which has been more extensively explored than the other oceans, twenty-nine species have already been secured, and from the few samples of the bathypelagic fauna taken in other regions of the world, it may be assumed that the nemerteans are equally present elsewhere and should be looked upon as making up no insignificant portion of the deep-sea life.

In regard to the position and number of the gonads it will be observed that the ovaries always occupy their primitive positions in the body, a single gonad developing in each of the larger interdiverticular spaces. No ovaries occur at either end of the body and frequently the number is reduced below that of even the larger intestinal diverticula. This is due to the failure of gonads to develop in some of the interdiverticula spaces. Not rarely do the females indicate that there is a sequence in the discharge of the ova, those in the middle of the body developing first, and after they have been discharged the gonads nearer the anterior and posterior ends bring their contained ova to maturity. This is indicated by the observed cases in which the ovaries near the middle of the body have been emptied, while those nearer both ends of the worm are still in growth.

Spermaries. In the male the position of the gonads is quite different from that of the littoral species, for the spermaries have migrated from their primitive interdiverticular location to new positions in the head. In the supposedly more primitive bathypelagic forms, as indicated by their sequence in the above table, the spermaries are found in a single row or elongated group on each side of the median line near the ventral surface of the body and posterior to the brain.

In the more highly specialized forms, as Nectonemertes, the spermaries extend further forward, and lie not only behind but also beside the lateral borders of the brain, while in Pelagonemertes and Balaenanemertes they reach the maximum displacement from their primitive interdiverticular positions and are situated beside or entirely in front of the brain. Sometimes, as in *Pelagonemertes brinkmanni,* they are pressed so close against the anteriolateral margins of the head that the change of pressure that occurs while the worms are being brought from their natural habitat to the surface causes such a distension of the body-tissues that the spermaries are forced through the delicate cephalic musculature. In such cases they appear in the preserved specimens like lobed appendages on the anterior margin of the head (Plate **2**, fig. 11; Plate **26**, fig. 165).

This anterior migration of the male gonads is evidently correlated to a certain extent with a similar forward extension of the diverticula of the intestinal diverticula. In *Pelagonemertes brinkmanni*, for example, both the spermaries and the diverticula reach far in front of the brain (Figure 44), while in the less specialized genera, as Planonemertes, Dinonemertes, and Phallonemertes both these systems lie behind the brain. There is, however, much variation in the relative anterior extent of these organs in the different forms, and frequently the spermaries are closely crowded together in the parenchyma before, beside, or behind the brain without reference to the caecal diverticula.

From the limited data available the correlation between the number of gonads and the number of intestinal diverticula appears not to be very close in the male, although such correlation holds for the female. Paradinonemertes, for example, has only two pairs of spermaries, although there are forty to fifty pairs of diverticula, and *Pelagonemertes brinkmanni* has as many spermaries as has *P. rollestoni*, but in the latter the diverticula are far more numerous. Nevertheless a certain correlation holds for most of the genera, if not for the species, for as a rule the genera which have numerous diverticula have a larger number of spermaries than those with few.

Ovaries. In the case of the female, in which the ovaries retain their primitive interdiverticular positions, the number of ovaries is correlated somewhat closely with the number of intestinal diverticula and this correlation holds for individuals as well as for species. In most forms the ovaries extend from the pyloric opening into the intestine to the constriction of the body anterior to the tail; that is, through those parts of the body where the intestinal diverticula are most fully developed. As a rule therefore, the ovaries are less numerous than the diverticula. *Planktonemertes agassizii*, for example, has from fifteen to thirty pairs of ovaries associated with forty to sixty pairs of diverticula. One specimen of *P. joubini* described in this report had eighteen pairs of each, with two supernumerary ovaries on one side (Plate **25**, fig. 153). In *P. moseleyi*, the number of ovaries somewhat exceeds the number of diverticula, and this is the case with most specimens of *P. brinkmanni*. These latter conditions indicate a more advanced state of reduction in the diverticula than has occurred in the primitively more numerous gonads. In the other pelagic forms, however, the gonads have suffered a more extensive reduction than have the intestinal diverticula.

The position which the ovary occupies with relation to the lateral nerve-cords depends upon the degree to which the latter have been shifted toward the median line from their primitively lateral position. In general, however, the lateral nerve-cords lie so near the median line that the major portion of the space between the intestinal diverticula lies lateral to the nerve-cord, and hence the ovary lies in that position, the oviduct opening between the position of the nerve-cord and the lateral margin of the body. In Pelagonemertes, some of the ovaries and oviducts lie lateral to the nerve-cord but the ovaries are more frequently situated so that the oviduct opens on the median side of the nerve-cord. In Armaueria also, the most anterior and posterior gonads have a lateral position but in the middle of the body, they lie medially. In Balaenanemertes the nerve-cords are more widely separated and the ovaries are situated medially to them.

Insemination. A very peculiar adaptation to insure insemination occurs in *Phallonemertes murrayi*, where Brinkmann ('12) discovered a remarkable modification of the reproductive organs in the male. In this bathypelagic nemertean from the North Atlantic the spermaries are provided with muscular walls as in Nectonemertes, and the sperm-ducts, instead of ending in minute papillae on the surface of the head, as they do in all other species, are prolonged in some specimens in slender, muscular penes (Figure 36, 37). There are from five to seven pairs of these organs on the ventral side of the head, corresponding to the same number of cephalic spermaries. That the penis is actually an outgrowth from the body-walls is shown by the fact that its walls, like those of the body, consist of basement layer and circular and longitudinal musculatures. The organ is evidently capable of muscular contraction and may be considered a true copulatory organ. In several of the specimens collected, the penes were torn from their insertions in the body-walls, and Brinkmann offers the suggestion that they may have been inserted into the ovaries of the females and held there to serve as spermatophores. The female of this species has about twenty-five pairs of typical interdiverticular ovaries.

The significance of the peculiar modifications of the reproductive organs mentioned above may be suggested from a consideration of the environment in which the bathypelagic nemerteans live. Although they occur in all the great oceans, with the possible exception of the Antarctic, they are rarely abundant, only a single individual being usually taken after many hauls of the net from the water-layer in which they are known to occur. In this respect they differ from many other pelagic organisms which are associated in such vast swarms that thousands of individuals may be collected in a single haul. The comparative scarcity of the pelagic nemerteans is indicated by the fact that in only eleven of the forty-seven known species have both sexes as yet been discovered, and more than half the species are known from but a single specimen. With such a sparse population in the vast areas of the open ocean, the survival of a sexually produced species obviously requires entirely different adaptations than those which suffice for littoral species. A general account of these adaptations is given by Coe ('20) in a paper on sexual dimorphism in nemerteans.

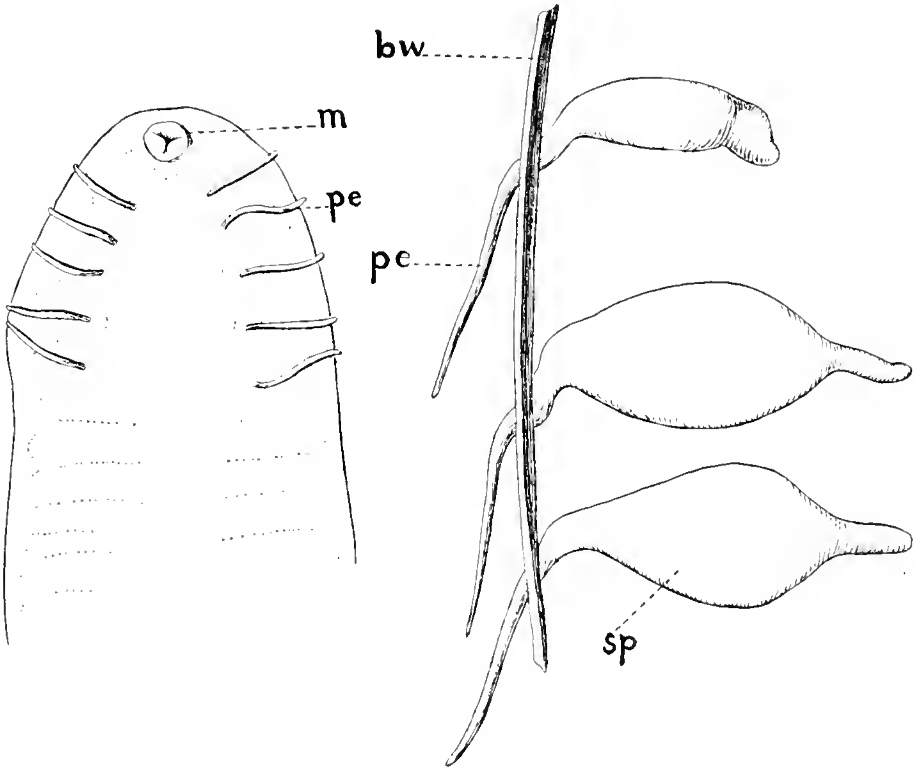

Fig. 36, 37.— *Phallonemertes murrayi* Brinkmann. Fig. 36, outline of ventral surface of head showing the five pairs of slender papillae (*pe*), on the summit of which the sperm-ducts open; *m*, mouth. Fig. 37, diagram of three spermaries (*sp*) of same species, showing the relations of the genital papillae (*pe*) to the body-wall (*bw*). (After Brinkmann, 1912).

The primitive condition of the reproductive organs prevails in most of the littoral species. The sexes are, as a rule, separate and in both sexes the gonads occupy similar positions along each side of the body throughout almost its entire length back of the head. The gonads are usually in pairs, alternating regularly with the intestinal lobes, or diverticula. The number of such gonads may be many thousands in a large worm, and each ovary as well as each spermary produces a large number of gametes. It is estimated that a large, female Cerebratulus, which may reach a length of two meters or more, produces a hundred million eggs in one season. These are all discharged within the space of a few days. And in some littoral species no larger than Nectonemertes, the number of eggs produced is perhaps a hundred times greater than in the latter.

The littoral forms, moreover, live in such a comparatively limited environment that the survival of the species results from the random discharge of the sexual products, when mature, into the surrounding water. No instinct guides the worms to congregate in the breeding season as in certain species of annelids, but as in many of the mollusks and other sedentary organisms the scattering broadcast of vast numbers of minute gametes suffices for propagation. The worms appear to be stimulated by the presence in their neighborhood of the gametes of the other sex to discharge their own sexual products, if mature. The eggs also form secretions which react upon the sperm-cells in their immediate vicinity.

But these primitive methods would not avail in the case of the sparse population of pelagic nemerteans, nor are they universal among littoral, fresh-water, or land forms. In all these groups these are species which exhibit primitive pairing instincts, and in some there is actual insemination, associated with viviparity. In the fresh-water Stichostemma, although the worms are hermaphroditic, cross fertilization usually occurs as a result of their pairing instincts. Two worms of this species place their bodies side by side in a sheath of mucus which they secrete about themselves. Into this mucous sheath, the eggs of one worm are extruded together with the spermatozoa from the other worm, the eggs of the latter not yet being mature. At a later time the worm which furnished the spermatozoa pairs again and discharges its eggs to be fertilized by a third individual, and so on.

In the Bermuda land nemertean Geonemertes, as described by Coe ('04), there is a similar pairing but in this case the spermatozoa of one worm are transferred to the widely opened oviducts of the other, providing for the fertilization and subsequent development of the eggs within the body of the parent. The young worms break out of the mother's body when sufficiently matured. Here there is not only a conservation of the sexual products, but also the provision of a suitable environment for the development of the young for which sufficient water is lacking in the natural habitat of the parents.

In Prosorhochmus and in several species of Tetrastemma hermaphroditism also occurs, and the former is viviparous. Several species of Lineus are viviparous but not hermaphroditic. In all of these cases the spermatozoa of one individual enters the oviducts of another to fertilize the eggs contained therein.

In all viviparous species there is but a relatively small number of ova produced. Usually a single ovum in each ovary develops at the expense of the other primitive ova which the gonad originally contained.

Turning now to the pelagic nemerteans, we find a similar reduction both in the number of eggs produced and in the size and number of the spermaries.

This reduction in the number of gametes which an individual produces is correlated with the remarkable adaptations to insure their conservation which are found in the pelagic forms. Thus we may account for the tentacles which develop in the sexually mature male of Nectonemertes, on the assumption that these muscular appendages enable him to cling to the female which he may encounter when, or even before, her sexual products are mature. Thus entwined the two may float along far beneath the surface of the ocean by slight movements of the horizontal and caudal fins with which they are provided. When the ova of the female are fully ripe the contraction of the muscular walls of the spermaries of the male will supplement his frail body-muscles in forcibly ejecting the spermatozoa in close proximity to, or even into, her open oviducts. The one, two, or three ova in each ovary would thus seem to have a far better chance of being fertilized than would otherwise be the case. And yet there must be some element in the environment which is unfavorable to the rapid multiplication of these worms, for they would otherwise be found in greater abundance.

Only in Nectonemertes and Pelagonemertes are the muscular walls of the spermaries so well developed. In some of the other forms, as *Neuronemertes aurantiaca,* for example, the dorsoventral muscles so closely invest the spermaries that their contraction serves the same function as the spermatic musculature described above.

In Phallonemertes, as stated above, the long muscular genital papillae (penes) may function in a somewhat similar manner, as was suggested by Brinkmann ('12).

In *Plotonemertes adhaerens* a pair of large, muscular, external appendages on the ventral side of the body (Figure 54, 55) has been described by Brinkmann ('17) as possibly being of the nature of adhesive organs, by means of which the male may cling to the female during insemination, or at least during the discharge of his spermatozoa coincident with the liberation of ova from the body of the female.

The oviducts of the pelagic nemerteans are not usually formed long before the discharge of the ova, but it is not improbable that the eggs of some of the species are fertilized while still within the body. It is even possible that partial development may occur, although no confirmatory evidence is available.

Finally the question may be raised as to whether all the eggs produced by an individual are discharged at one time. In the littoral species such is usually not the case, and in the pelagic forms there is such a considerable difference in the development of the eggs in different ovaries that there is good reason to assume that only a portion of the eggs are discharged at once. There is positive evidence that this sometimes occurs, for empty ovaries have been found in the middle regions of the body while immature gonads were situated both anteriorly and posteriorly.

Evidence from such forms as Nectonemertes and Balaenanemertes, in which the growth of tentacles is associated with the maturity of the sexual products, proves that in these forms at least sexual maturity occurs but once in the animal's life and that this is independent of the season of the year. At the great depths at which these worms live the water is uninfluenced by climatic changes at the surface.

Spermatogenesis. When fully developed, the spermaries encroach to a great extent on the space normally occupied by the other organs. In Nectonemertes, for example, a transverse section of the head (Plate **17**, fig. 107, 108) shows that the gonads occupy the major portion of the space within the cephalic wall, crowding the diverticula of the intestinal caeca close up against the dorsal wall of the head and almost obliterating their lumen. The lateral nerve-cords and the blood-vessels suffer a corresponding change in position.

In certain species, however, as *Dinonemertes alberti*, a space remains between the brain and the most anterior intestinal diverticula, leaving ample room for the growth of the spermaries without encroaching on the alimentary canal (Figure 38).

The wall of the spermary usually consists mainly of connective tissue, but on its inner surface there is commonly developed a system of spiral muscular fibers which in some forms, as Nectonemertes and Phallonemertes, may reach massive proportions (Plate **18**, fig. 113, 114). In *Nectonemertes mirabilis*, this spiral musculature consists of closely placed, flattened bundles of fibers, like plates set side by side at right angles to the wall. Large ovoid nuclei are scattered along the enlarged inner sides of the flattened bundles (Plate **18**, fig. 114).

The general shape of the gonad in this species resembles a retort with its neck directed ventrally and laterally. The germinal cells occupy only the body of the retort-shaped organ, the neck serving as a duct for the discharge of the spermatozoa. At about the middle of the neck of the retort the muscular wall of the gonad is terminated sharply by a narrow constriction which marks the end of the germinal portion of the gonad. The opening in this constriction leads into a spacious chamber, the wall of which consists of a single layer of cuboidal epithelium, resting upon a thin layer of connective tissue and provided with a few fine, longitudinal, muscular fibers. This chamber serves as a seminal vesicle and into it the ripe spermatozoa may collect previous to their discharge from the body. A short sperm-duct leads from the seminal vesicle to the opening on the genital papilla (Figures 5, 39, 40).

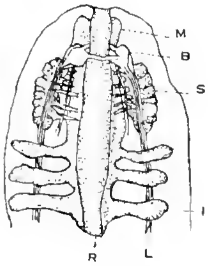

Fig. 38.—*Dinonemertes alberti* (Joubin). Dorsal view of anterior portion of body, showing mouth (M), anterior intestinal diverticula (I), brain (B), dorsal commissure rhynchocoel (R), lateral nerves (L), spermaries (S), and sperm-ducts. (From Brinkmann, 1917a after Joubin (1906)).

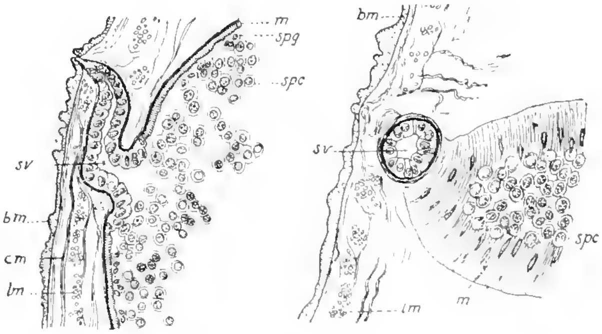

Fig. 39, 40.—Spermaries of *Nectonemertes mirabilis* Verrill. Fig. 39, portion of a transverse section of body, showing an immature spermary with developing seminal vesicle (*sv*) with its simple epithelial lining extending through body-wall. The muscular wall (*m*) of the gonad encloses the developing spermatogonia (*spg*) and spermatocytes (*spc*); *cm* and *lm*, circular and longitudinal body-musculatures, respectively; *bm*, basement-layer. Fig. 40, portion of transverse section of body, showing tangential section of a gonad with the musculature (*m*) cut longitudinally, and the seminal vesicle cut transversely.

The opening of the seminal vesicle to the exterior appears to remain closed except at the moment when the spermatozoa are discharged and the ripe spermatozoa collect in compact bundles in the efferent duct. The hundreds of spermatozoa of a bundle all lie parallel, with their heads directed toward the opening. The genital pore is guarded by a pair of lips on the summit of the small papilla already mentioned.

In the mature spermary (Plate 18, fig. 114), the contents of the gonad consist of germinal cells in the various stages of spermatogenesis, with a small central cavity containing large bundles of spermatozoa. The nuclei of the germinal cells of each of the successive stages of development are characteristic and sharply defined, but, as in many other animals, the cell-outlines are indistinct. If development has not progressed too far the entire series of changes may be followed in a single section (Figure 41).

In such a gonad, a single layer of large, oval nuclei lying just internal to the muscular wall represent the spermatogonia (*spg*), but in the later cell-generations the nuclei are arranged in groups. The nuclei of the primary spermatocytes are large and spherical and are imbedded in a continuous cytoplasmic mass constituting a cytophore. The smaller secondary spermatocytes are similar, while the spermatids in the various stages of transformation to spermatozoa are thickly packed side by side in conical masses. As the cells elongate and the tails of the spermatozoa appear, they retain their conical arrangement, the heads of the spermatozoa being imbedded in the apical condensation of the cytophore (Plate **17**, fig. 109). When nearly mature the very slender spermatozoa lie in more parallel bundles in the lumen of the gonad. The cytophore later disintegrates and the fully formed spermatozoa pass out toward the neck of the gonad. In some cases large groups of parallel spermatozoa have been found in the sperm-duct.

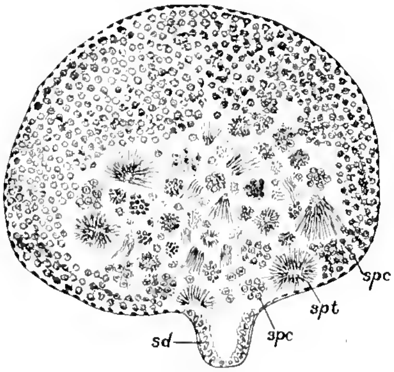

Fig. 41.—Section of spermary of *Planonemertes lobata* Coe, showing many stages in spermatogenesis; *spc*, spermatocytes; *spt*, cytophores of spermatids in process of metamorphosis into spermatozoa; *sd*, sperm duct.

There is no evidence that any of the pelagic forms has more than a single reproductive period. The observations of Brinkmann ('17a), on the contrary, prove that in Nectonemertes and Balaenanemertes there is a close correlation between the growth of the tentacles and the maturation of the germinal cells. This indicates that death occurs after a single reproductive period.

Ovogenesis. The ovary in its earliest stage of development is a thin-walled sac of connective tissue lined internally by a layer of epithelial cells without distinct cell-boundaries, forming a continuous syncytium. In this protoplasmic layer, two types of cells can be distinguished, namely, potential egg-cells and follicle-cells. The former are many times the larger and project above the general level of the syncytium, being connected with the other cells only by their basal portions. The follicle-cells are vastly more numerous and smaller and surround the basal stalks of the egg-cells and eventually cover the entire egg.

This primitive condition, similar to that found in Drepanophorus, is but little modified in Plionemertes in the later course of ovogenesis (Plate 15, fig. 102). As development proceeds, the young ova extend farther and farther into the lumen of the ovary, and each is connected with the peripheral syncytial layer by a narrow stalk directly continuous both with the cytoplasm of the egg and with that of the syncytium. The follicle-cells soon begin the elaboration of yolk which is first deposited as small globules within the follicle-cells and is then passed through the stalk of the ovum into the cytoplasm of the latter. Many of the young ova doubtless degenerate and supply nourishment for relatively few definitive ova. The number of eggs which attain full maturity in an ovary of this type is not known, but is presumably at least two or three.

An even simpler mode of development of the ova occurs in Protopelagonemertes, which Brinkmann ('17a) considers the most primitive of the pelagic forms. Here there appears to be a considerable number of ova formed in each gonad, but this is not proved because the later stages were not found.

In other forms, as in Nectonemertes, for example, where but one or two ova mature in each ovary, the egg-cells are entirely surrounded by the syncytial follicle and are thus enabled to receive yolk through their protoplasmic connections on their entire surface (Plate 19, fig. 119). The relative positions of the gonads in both sexes are shown in Figure 42.

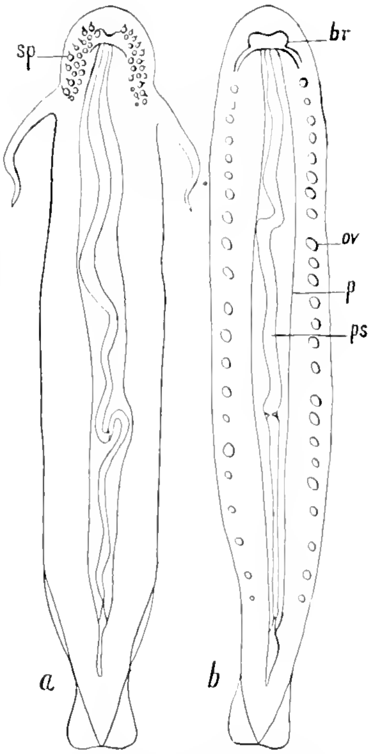

FIG. 42.—Sexual dimorphism in *Nectonemertes pelagica* Cravens & Heath, the adult male (*a*) being provided with cephalic spermaries (*sp*) and tentacles, while the female (*b*) has numerous paired ovaries in the interdiverticular spaces nearly the entire length of the body and is without tentacles.

An interesting modification of both these types and in some respects intermediate between them is found in *Planktonemertes agassizii*. Brinkmann ('17a) states that the abortive ova are ordinarily discharged at the same time as the mature ovum. Undoubtedly this sometimes occurs from the added internal pressure when the animal is brought from great depths to the surface of the sea, but it seems doubtful if it is a normal process. More probably most of them are absorbed by the ovum in its last stage of growth. Evidence for this is found in the fact that the most fully matured ovaries in various species contain only the egg itself, the entire follicular epithelium, including abortive eggs and the peripheral yolk-forming cytoplasm, having been entirely absorbed. It seems quite possible that in some species the eggs in an ovary may mature successively and be discharged at intervals, as occurs in some of the fresh-water and littoral forms but there is at present no proof that such is the case. In *Planktonemertes agassizii* the process of ovogenesis is somewhat different from that in any of the pelagic forms as yet studied and warrants a more detailed description.

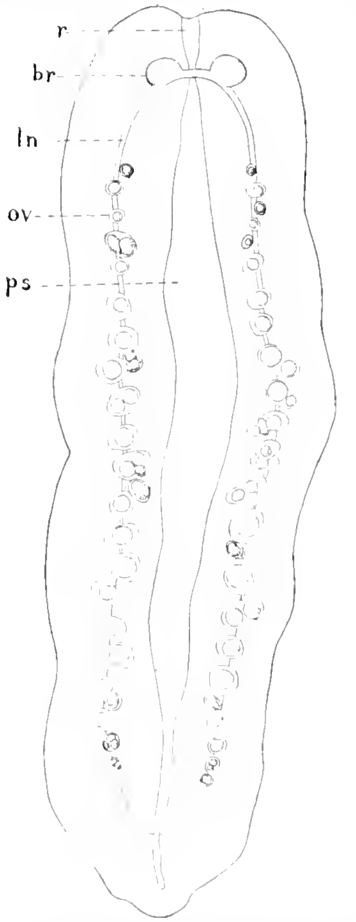

FIG. 43.— *Planktonemertes agassizii* Woodworth. Outline of body of female from dorsal surface, showing the ovaries (*ov*), each with one or occasionally two large ova, situated above the lateral nerves on each side of the body. × 6.

In the earliest stage represented (Plate 8, fig. 55), the young ovary consists of a narrow sac with a lining of fairly sharply demarcated follicular cells and a large central cavity in which a considerable number of large amoeboid cells are suspended by slender protoplasmic processes. These are the primitive ova which have migrated from the follicular layer and increased enormously in size (Figure 48). They are each provided with numerous pseudopodia, some of which extend from the cell-body through the ovarian cavity to enter into cytoplasmic connection with the follicular cells. Some of the latter appear to have been torn loose from the wall and are attached to pseudopodia which end freely in the ovarian cavity. Others lie freely scattered among the pseudopodia or have been engulfed by the latter (Plate 7, fig. 50–53). Eventually one of these primitive ova begins a rapid growth and finally absorbs all its sister-cells, including the follicle-cells, to become the single definitive ovum which develops in each gonad (Figure 43).

The follicle-cells are more or less completely surrounded by the protoplasmic syncytium composed at first of the pseudopodial processes of the ova. They nevertheless retain their own cellular outlines for a considerable period, even after they are engulfed by the pseudopodia. Gradually, however, many of these cells lose their identity in the common protoplasmic mass, and only their nuclei remain to indicate the original cell (Figure 48).

At intervals along the wall of the ovary occur oval granular nuclei (Plate **7**, fig. 50 and 51) which belong to the wall itself. Widely separated and very fine muscle-fibers also occur, as Brinkmann ('17a) noted for *P. vanhöffeni*. As the ovary approaches maturity the musculature increases somewhat, particularly along its medial and lateral surfaces.

The follicular cells divide frequently. A single cell in the metaphase of karyokinetic division is shown at *x*, fig. 52, Plate **7**. The chromosomes are numerous, but the exact number could not be determined. The cells of the follicle become differentiated into three types, (*a*) those that retain their original dimensions and cell-outlines and which soon begin the deposit of yolk, (*b*) those which lose their cell-boundaries and divide repeatedly in the cytoplasmic syncytium, and (*c*) those which invest the definitive egg-cell (Figure 48).

The yolk-forming cells are gradually separated from the ovarian wall and become scattered in the cytoplasmic mass which eventually obliterates the entire lumen of the ovary. They soon begin the deposit of yolk either in the form of numerous small globules or in one to several larger vacuoles (Plate **7**, fig. 54). The nucleus of the cell becomes smaller and gradually disintegrates, the cell-boundaries disappear and the yolk-granules come to lie free in the cytoplasmic mass. In the later stages of ovogenesis, they are drawn into the egg-cell through the bridges connecting it with the peripheral yolk (Plate **8**, fig. 58–60).

The second type of follicle-cells, the nuclei of which occur abundantly in all parts of the syncytium, are nutritive in nature and with the maturity of the egg are gradually assimilated themselves.

In the third type, the cells of which closely invest the egg-cell after it has begun the absorption of yolk, the cell-body is vacuolated and doubtless supplies nutritive substances directly to the egg (Plate **7**, fig. 54).

The fate of the amoeboid primitive ova must now be followed. With the growth and multiplication of the follicle-cells, as described above, the ovarian cavity is gradually filled completely and the young ova closely invested by the syncytial mass. The ova themselves have not increased in size as regards their cell-body proper but have only contributed to the cytoplasmic mass in communication with their pseudopodia (Plate **8**, fig. 56–58).

With the increase in the syncytial mass, comes a great increase in the volume of the ovary, but, as the figures on Plate **8** indicate, this enlargement occurs mainly by increase in the girth of the ovary, there being very little increase in length. The amoeboid ova are at first scattered through this syncytial yolk-mass but are gradually collected either into a single group toward one end of the mass or into two groups, one at either end (Plate 8, fig. 56–58). In the latter case, two eggs may be formed instead of one as usual. The ovum which lies nearest the center of the mass takes on a new activity, the cells about it becoming radially arranged and vacuolated, with rather prominent nuclei, as shown by the lower egg in fig. 54, Plate 7. This cell now grows rapidly in size; its pseudopodia are continuous with the protoplasm of the yolk-mass and narrow spaces appear between the pseudopodia, separating the cell-body from the syncytial mass (Plate 8, fig. 58–60). It is now recognizable as the definitive egg-cell. Occasionally two such eggs are formed, as stated above, one being derived from one of the amoeboid cells at one end of the ovary and the other from the opposite end (Plate 8, fig. 50). A similar condition occurs in Pelagonemertes (Figure 44).

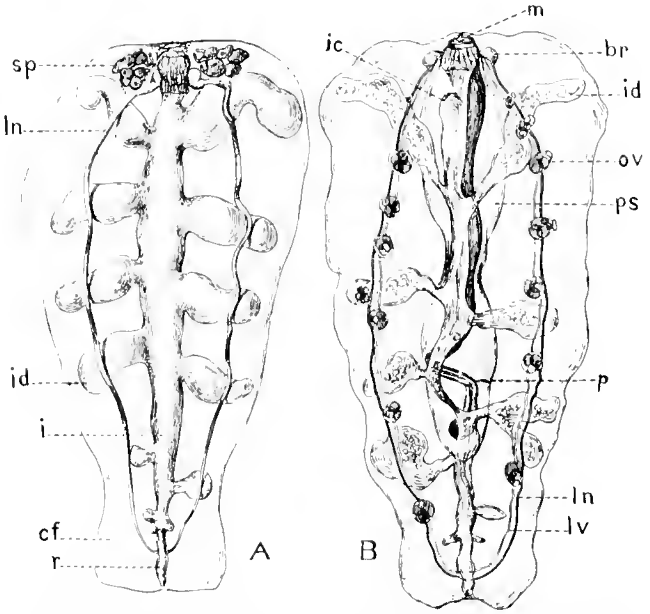

Fig. 44.— Sexual dimorphism in *Pelagonemertes brinkmanni* Coe. Mature male (A) and female (B) from ventral surfaces, the male having five pairs spermaries (*sp*) in front of the brain; while in the female the seven pairs of ovaries (*ov*) are symmetrically distributed throughout the length of the body; *br*, brain; *cf*, caudal fin; *i*, intestine; *ic*, intestinal caecum; *id*, intestinal diverticulum; *ln*, lateral nerve; *lv*, lateral vessel; *m*, mouth; *p*, proboscis in the distended sheath (*ps*); *r*, rectum.

With the establishment of the definitive ovum the previously formed yolk-globules migrate rapidly into it through its protoplasmic processes which remain connected with the syncytial mass and the cell grows until it has absorbed the greater part of the preformed yolk and therefore fills almost the entire ovary. A relatively thin layer of yolk-forming cells, however, remains just inside the ovarian wall as a peripheral shell to provide nourishment for the later growth of the egg. This shell of yolk-cells is separated from the egg by a space filled with fluid, but is connected at frequent intervals by protoplasmic bridges through which the elaborated yolk-globules reach the cytoplasm of the egg (Plate 8, fig. 60). When fully formed the egg measures about 1.5 mm. in diameter and is crowded with yolk-globules of various sizes, those nearest the nucleus being much larger than those nearer the periphery. Interspersed among the yolk-globules, and collected particularly in a crescentic zone of more deeply staining cytoplasm about the nucleus, are numerous perfectly spherical vacuoles which presumably contained in life a more soluble form of nutritive material which has disappeared in the preparation of the slides.

The nuclei of the primitive amoeboid ova are large as compared with the size of the cell and each contains a large, spherical nucleus. At the yolk-forming stage, however, the primary nucleolus is supplemented by many much smaller, secondary, nucleoli which lie against the nuclear membrane (Plate 7, fig. 54). Later the primary nucleolus disappears and the secondary nucleoli become still more numerous. Brinkmann ('17a) states that he has observed the migration of similar nucleoli into the cytoplasm.

The primitive amoeboid ova which are not destined to become definitive egg-cells, apparently because of their position farther from the center of the syncytial yolk-mass, have two possible future histories. Some of them, as shown (Plate 8, fig. 56, 57), while still within the yolk-mass, become surrounded by numerous small cells, and degenerate, their substance being elaborated by the group of small cells into the common nutritive substance of the yolk-mass. A cluster of small nuclei marks the final stage in their dissolution.

Others of the primitive ova migrate toward one pole of the ovary, and after the absorption of most of the yolk-material into the definitive egg-cell, become imbedded in the peripheral yolk. Their cell-bodies are still united with the surrounding yolk-mass by cytoplasmic connections through a thin fluid space after the general manner of the definitive ova (Plate 8, fig. 56–58). They do not increase in size, however, although the primary nucleolus disappears and is replaced by many minute secondary nucleoli. In this respect these abortive ova also resemble the definitive egg. They may later flatten out against the ovarian wall and persist even after the discharge of the fully formed egg (Plate 8, fig. 59, 60). Such abortive ova (*ov'*) are shown for Cuneonemertes in Figure 45.

Brinkmann ('17a) figures for Crassonemertes a condition apparently quite similar to that here described for Planktonemertes, although he gives few details of the relations of follicle and egg-cells. He describes the latter as projecting above the ovarian epithelium, remaining connected with the other cells only by their basal portions. He also states that the formation of yolk takes place in the differentiated epithelium from whence the yolk-granules migrate into the ova. He thinks there is no doubt that a considerable number of ova are formed in each ovary. He correctly recognized the ovaries as very immature, but his figure shows that in Crassonemertes also the young ova are apparently amoeboid, as in Planktonemertes, and later stages would very possibly have shown that in both forms these amoeboid ova have a similar developmental history, and that usually but a single ovum reaches maturity in each ovary.

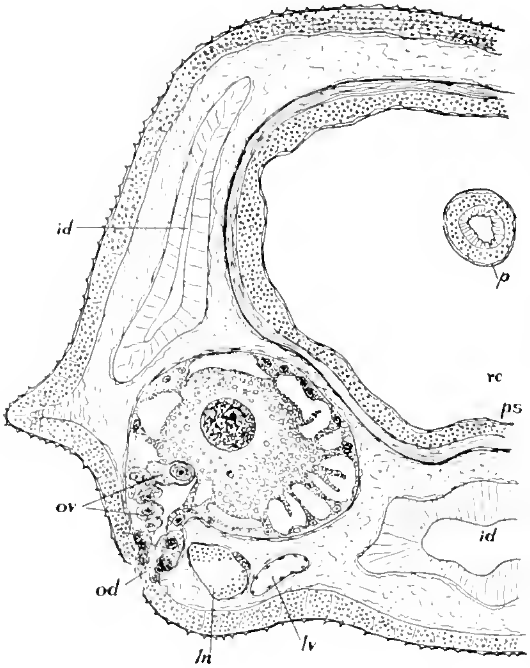

Fig. 45.—*Cuneonemertes gracilis* Coe. Portion of transverse section near middle of body, showing the ovary with its single large, amoeboid ovum filling nearly the entire lumen of the ovary, with several abortive ova (*ov*) near the oviduct (*od*). The lateral nerve, with its single fibrous core, shows a distinct nerve-cord muscle on its dorsomedian border; *id*, dorsal and ventral lobe of intestinal diverticulum; *p*, proboscis in the greatly distended rhynchocoel (*rc*); *ps*, proboscis-sheath, with distinct longitudinal and circular muscular layers.

In Pelagonemertes the conditions are somewhat different, for here, as in most other pelagic forms, the young ova remain imbedded among the follicular cells instead of projecting out into the lumen as described above for Planktonemertes. In many forms both the follicle-cells and the egg-cells lose their cell-membranes at an early stage in the growth of the ovary, the nuclei of both types of cells lying free in a common protoplasmic layer surrounding a large central cavity.

From such a syncytium several of the numerous egg-nuclei increase in size, with the follicle-nuclei grouped loosely around them. An incomplete cell-membrane is formed around the cell-body of each of the eggs, leaving them connected with the common protoplasmic mass by broad pseudopodia.

The follicle-cells now form a definite layer surrounding each egg and begin the elaboration of yolk. As the yolk-globules are formed, they pass through the protoplasmic connections into the eggs where they are deposited in the rapidly increasing cytoplasm. Gradually those eggs which are nearer the center of the body, that is farthest from the oviduct and presumably nearest the greatest supply of nourishment from the surrounding tissues, become surrounded by a

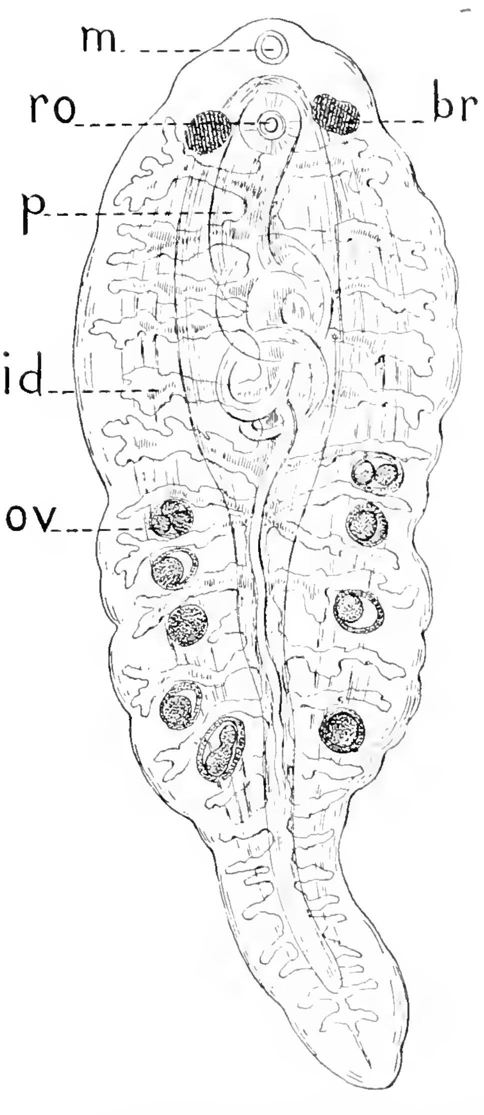

FIG. 46.—*Pelagonemertes rollestoni* Moseley. Female, showing the four or five ovaries (*ov*) on each side, each with from one to three ova; *ro*, rhynchodeal opening; other lettering as in Fig. 47. (After Bürger, 1909).

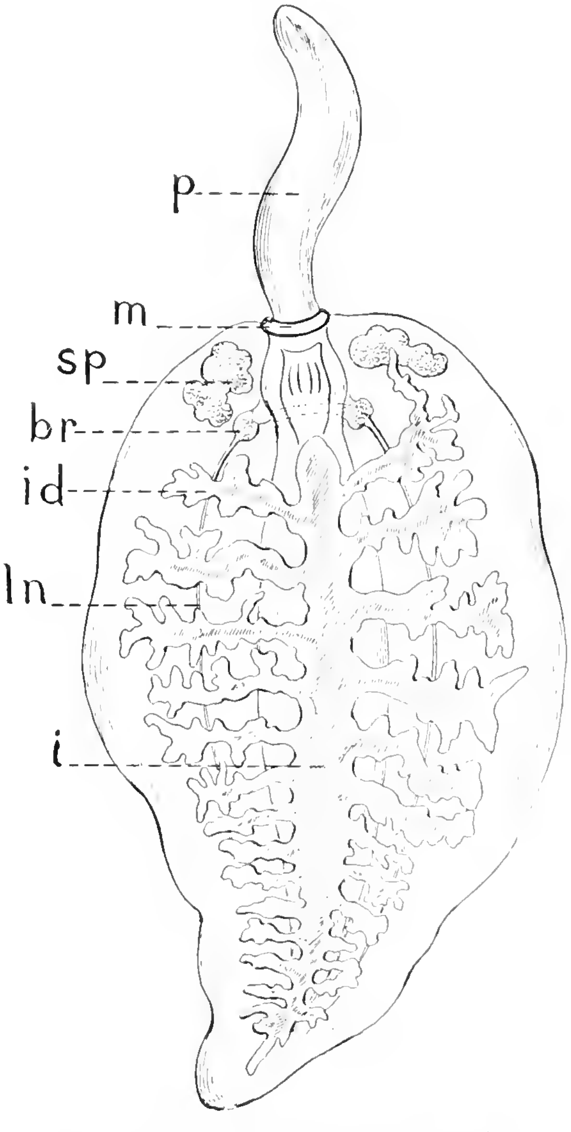

FIG. 47.—*Pelagonemertes rollestoni* Moseley. Adult male, with a single group of five or six closely placed spermaries (*sp*) on each side of the head; *p*, partially extruded proboscis; *m*, mouth; *br*, brain; *i*, intestine; *id*, intestinal diverticulum; *ln*, lateral nerve. (After Bürger, 1909).

larger number of follicle-cells and grow with increasing rapidity, while the others have but few follicle-cells and cease their growth and even decrease in size by the transfer of their substance through the follicular syncytium to the definitive egg-cell. Eventually one, two or three large ova occupy nearly the entire ovary, while the other, abortive, eggs lie imbedded in the thin peripheral layer of yolk-forming cells which lines the ovarian wall and with which the definitive ova remain in connection by means of their protoplasmic processes until they are fully matured (Plate **28**, fig. 176, 176a).

In *Pelagonemertes rollestoni* the number of gonads is much reduced in both sexes (Figure 46, 47).

In *Balaenanemertes lobata,* Brinkmann found a single large nucleolus in the early ovocyte, but this disappears in a later stage of development. In one case it was thought to pass directly through the nuclear membrane. In this minute species the ovum situated nearest the dorsal side of the ovary grows at the expense of the others by absorbing all the yolk produced by the syncytial follicle with which it is connected by broad protoplasmic processes. When fully grown the egg not only fills the entire ovary, but reaches almost the entire distance from dorsal to ventral body-wall, displacing the intestinal diverticula and adjacent organs. These eggs reach a diameter of 1 mm., or one tenth the length of the entire body. They are orange in color (Plate **1**, fig. 7), and very conspicuous in the living worm.

The abortive eggs as well as the entire follicular syncytium are absorbed, there never being more than a single egg in an ovary. Even then the drain on the nutritive materials of the body is so great that a portion of the ovaries matures before the others are fully active (Plate **1**, fig. 7).

The largest ova produced by any of the pelagic nemerteans thus far studied are found in *Dinonemertes investigatoris* and measure 2.5 mm. in diameter. Since there are forty-two to fifty pairs of ovaries and several eggs may develop in each, these gigantic nemerteans vie with some of the littoral species in fecundity. The comparative sizes of the definitive ovum, primitive ova, and follicle-cells in the successive stages of ovogenesis in *Planktonemertes agassizii* are shown in Figure 48.

Oviduct. Shortly after the yolk-mass has filled the lumen of the ovary and the definitive ovum has commenced its absorption of yolk, a group of cells near the end of the ovary nearest the lateral margin of the body begins the formation of the oviduct. The cells concerned in this process appear to be epithelial cells which have not participated in the growth of the follicle. They arrange themselves in a single layer which grows ventrally through the parenchyma toward the body-walls (Plate **8**, fig. 56–59). On reaching the musculature they separate the adjacent muscle-bundles of the longitudinal muscular layer and thus reach the circular muscles (Plate **19**, fig. 119). Here the oviduct spreads out somewhat close beneath the muscles and remains in this condition until the egg-cell has reached nearly its full size, when the fibers of the circular musculature are separated to allow a wide opening to the exterior on the ventral surface and usually some little distance lateral to the nerve-cord (Plate **8**, fig. 58, 59).

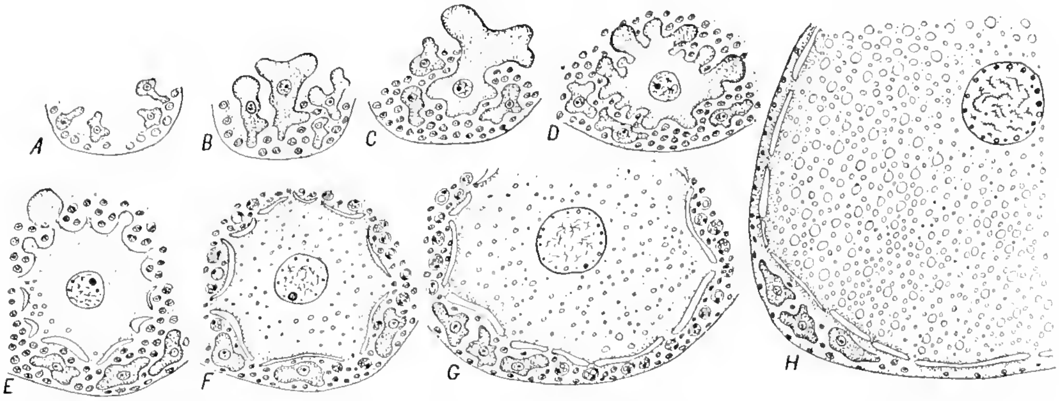

Fig. 48.— Diagrams illustrating the process of ovogenesis in *Planktonemertes agassizii* Woodworth. A, young ovary with four amoeboid ova projecting freely from the thin follicular epithelium into the lumen of gonad. B, somewhat later stage, showing the thickening of the follicular syncytium, with amoeboid ova increased in size. C, one of the ova greatly exceeds the others in size and is largely surrounded by the proliferating follicular syncytium. D, the definitive ovum is easily distinguished from the other ova by its much greater size and more numerous amoeboid processes. E, the amoeboid processes of the definitive ovum become intimately fused with the syncytium which now fills nearly the entire ovarian cavity. F, definitive ovum and some of the follicular cells increase in size and both begin the formation of yolk. G, yolk-formation in full activity, the yolk-granules being transferred from the peripheral syncytium into the definitive ovum; secondary nucleoli numerous. H, small portion of nearly ripe ovum, connected with the thin layer of peripheral syncytium by only a few, narrow protoplasmic processes; cytoplasm filled with yolk and lipoid vacuoles. Three abortive ova are shown in each diagram.

The cells lining the oviduct are regularly columnar in shape and are arranged in a single layer on a thin framework of connective tissue (Plate **19**, fig. 119).

Hermaphroditic gonads. In *Proarmaucria pellucida* a peculiar condition of some of the gonads was found in both of the two known representatives of that species. These specimens were apparently males with a double, irregularly crowded row of spermaries on each side of the body before, beside, and behind the brain (Plate **20**, fig. 120, 121). Several of the more posterior gonads, however, were not true spermaries, for each of them contained not only cytophores of spermatocytes but also one or more amoeboid ova (Plate **23**, fig. 139–143). In one of these specimens a similar, but much larger, hermaphroditic gland occurred near the middle of the body (Plate **20**, fig. 122). This contained about nine large, amoeboid ova besides many cytophores of spermatocytes. In one spermary near the tip of the snout a single ovum of similar appearance was found.

These ova are not to be confused with unicellular parasites, for they are to be found in several stages of development and are attached to a thickened peripheral syncytium of vitellogenous cells exactly as in the ovaries of the other forms (Plate **23**, fig. 139–143).

It is to be noted that in one of the specimens the hermaphroditic glands were in the position of the normal spermaries while in the other, which was provided with a full complement of spermaries, the single large hermaphroditic gland was situated in an interdiverticular space, presumably such a space as is occupied by an ovary in the female.

None of these gonads was fully mature as regards either of the sexual cells, although both the cytophores of spermatocytes and the yolk-bearing ova appeared perfectly normal (Plate **23**, fig. 139–143).

The interpretation of these observations is not entirely certain, but it appears that this species is irregularly hermaphroditic, even if it is at present doubtful whether either of the two kinds of sexual products formed in these gonads become functional. It may be noted in this connection that hermaphroditism occurs in several families of nemerteans, including those of marine, fresh-water, and terrestrial habitat and that in some of these each gonad is an hermaphroditic gland, similar to those in Proarmaueria (Coe, '04).

None of the spermaries of any of the other species studied contained either parasites or ova with the exception of two specimens of *Pelagonemertes brinkmanni.* In one of these worms there was a single amoeboid ovum quite similar to those described above, but its relations to the wall of the gonad were so obscured as to preclude a positive determination of its nature. The other specimen had eight large, amoeboid ova surrounded by spermatocytes in one of the cephalic gonads (Plate **28**, fig. 177) and a single ovum in an adjacent gonad. There can be no doubt that these large, amoeboid cells are actually primitive ova (and not unicellular parasites) because in some cases their relation to the surrounding follicle-cells is exactly the same as in the ovary.

Sections of this hermaphroditic gonad show that the organ has the fundamental structure of a spermary, with the characteristic thin wall of connective tissue in which a distinct spiral musculature is imbedded. Internal to this wall and entirely separated from it is an incomplete layer of follicle-cells exactly similar to those of a typical ovary. Several of the ova lie in close contact with the follicular cells and are evidently absorbing nourishment from the latter (Plate **28**, fig. 177). The ova occupy somewhat less than half of the space within the gonad, the rest being filled with groups of spermatocytes entirely comparable to those in the normal spermaries.

These conditions indicate that an occasional hermaphroditic gonad may occur in at least two genera of bathypelagic nemerteans. This may suggest an origin from an hermaphroditic ancestor or, more probably, an heredity sex differentiating mechanism which is somewhat unstable.

ECOLOGY.

The nemerteans belonging to the tribe Pelagica are evidently as truly pelagic organisms as any which inhabit the oceans. Their entire form and structure adapt them to their free-swimming life, but for many years after the first pelagic nemerteans were discovered it was uncertain whether they lived at or near the surface or far below in the depths of the ocean.

HABITAT

Most of the specimens secured in the earlier expeditions were taken in vertical hauls from depths of at least several hundred fathoms to the surface. The appearance of the specimens often indicated that they had come from great depths, for the epithelium covering their bodies was nearly all dislodged, the proboscis was usually torn from its attachments and spasmodically discharged, and in some cases the body-walls were ruptured and the internal organs partially extruded. In the more gelatinous forms, such as *Pelagonemertes brinkmanni*, even the spermaries in some specimens were forced through the delicate cephalic walls and were found on the outside of the head.

On some of the more recent expeditions, however, nets were employed which can be closed at any desired depth, and from the material found in such nets the precise habitat of a species can be determined. One specimen of *Pelagonemertes rollestoni*, for example, was taken in a closing net at a depth of between 750 and 900 meters in a region where the depth of the water was much greater, actually proving this to be a bathypelagic form.

Most of the ALBATROSS specimens were taken in nets drawn horizontally at a depth of about 600 meters in regions where the distance from the surface to the ocean's floor was two thousand meters or more. These nets were then hauled vertically to the surface, and although there is always a possibility that surface-living organisms may be included the vastly greater volume of water which passes through the net while it is being drawn horizontally at a given depth increases the chances that the organisms secured actually lived at that depth. When, as so frequently occurs in the case of the pelagic nemerteans, only a single individual is taken at a haul there can be no certainty as to the depth from which it came, although the chances favor the water-layer to which the net was lowered and drawn horizontally.

The most recent oceanographic expeditions have made their bathypelagic collections by means of the ingenious arrangement of nets so successfully employed in the explorations of the MICHAEL SARS deep sea expedition of 1910. By this method it has been possible to determine with a great deal of accuracy the depth at which each species of pelagic organism lives. The procedure consists in lowering a considerable number of nets of various sizes to different depths and drawing them horizontally for several hours simultaneously. Frequently nine or ten of these nets were employed, furnishing samples of the pelagic organisms from as many different water-layers (Figure 49).

By means of such a series of nets selective collections may be made of the organisms living in the various depth-zones, for those forms which are accidentally caught while the nets are being lowered or hauled to the surface will generally be easily distinguished as having a more superficial habitat than those taken at a greater depth by the greater abundance of the former in the more superficial nets. It is only where single or few individuals of a species are taken that any serious doubt will exist as to the depth at which they live.

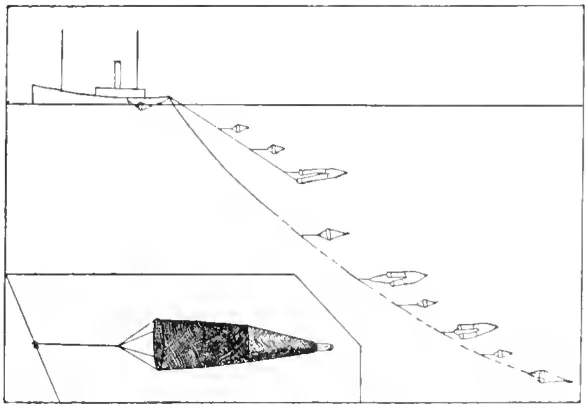

FIG. 49.—Diagram showing Hjort's arrangement of the series of nets used on the MICHAEL SARS expedition to secure samples of the pelagic life at different depths simultaneously. (After Murray & Hjort, 1912).

The depth at which each net was drawn is usually estimated at two thirds the length of wire used. These estimates will obviously be somewhat in excess of those reported by investigators who reckon the depth at only half the length of the wire. Both the speed of the ship and the character of the fishing-apparatus influence the depth at which the latter is actually drawn.

By a study of the hydrographic charts made for the collections, Brinkmann ('17a) shows conclusively that *Nectonemertes mirabilis*, for example, lives in a rather definite layer of water having a temperature of 6°C. or less and a salinity not exceeding 35‰. This layer is usually found at from 500 to 2000 meters below the surface in the regions of the North Atlantic Ocean where the species has been collected. The depth of greatest frequency was about 1300 meters. Of the eighty-two specimens taken by the MICHAEL SARS, sixteen came from about 1000 meters, fifty-two from about 1300, four from 1600, and ten from about 2000 meters. The vertical distribution of most these specimens is indicated on the accompanying chart (Figure 50), which represents a hydrographic section from Newfoundland to Ireland, compiled from the results of the MICHAEL SARS expedition. The Station numbers (77–93) are indicated at the top of the chart, the estimated depth in meters at the left and the number of specimens of *N. mirabilis* secured and at each station depth is shown. The temperature and salinity of the successive water-layers are also indicated.

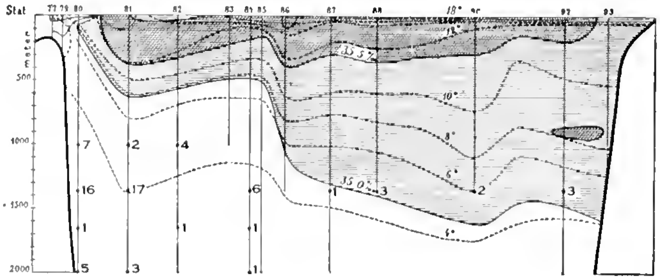

FIG. 50.— Hydrographic section, Newfoundland to Ireland, compiled from the results of the MICHAEL SARS expedition, 1910. Station numbers at top of chart; estimated depths at left; number of specimens of *Nectonemertes mirabilis* Verrill taken at each depth indicated by numbers on the vertical lines; salinity and temperature of successive water-layers as indicated. (After Brinkmann, 1917).

It will thus be seen that none of the seventy-five specimens indicated were taken at depths having a temperature above 6°C., and only fifteen at above 4°. The salinity was less than 35‰ in the case of all except eight of these specimens, and these were taken at three stations in the eastern Atlantic.

The extreme depth at which the species lives has not yet been determined, but only nine of these specimens came from so great a depth as 2000 meters.

That the species actually lives at about the depths indicated is conclusively shown by the catch of the nets lowered to different levels. At Stations 80 and 81, for example, no specimens of this species were taken from nets drawn at the surface, or at a depth of 66, 133, 200, 400, or 666 meters, while nine specimens came from the 1000 meter net, thirty-three from that at 1333 meters, one from 1666 meters and eight from 2000 meters. As the net drawn at 2000 meters was three meters in diameter while those at 1000 and 1666 meters were only three fourths of a meter, or only one sixteenth the surface-area, it seems not improbable that part or all of those credited to the greater depths may have been taken while the large net passed through the somewhat more superficial layer at about 1333 meters, where the species was most frequently found.

Nectonemertes mirabilis is, therefore, according to Brinkmann ('17) "a distinctly stenohaline and stenothermic species of marked bathypelagic character, its upper limit of vertical distribution being determined by the water-layers to which it is confined. It will be seen from the charts that this becomes deeper at the eastern stations where the isotherms and isohalines are lowered by the water-masses of the Gulf Stream. The species is thus not found in the intermediate and upper layers of the Gulf Stream, which again seems to explain the fact of its never being encountered in the Norwegian Sea. Hydrographic charts of the connecting waters between the Atlantic and the Mediterranean show that the Atlantic waters typical of the species do not penetrate into the Mediterranean; here accordingly the species has not been found. On the other hand, the connection between these Atlantic water-layers and the equivalent strata in the Pacific serves to explain the occurrence of the species in that sea." [1]

In no instance have bathypelagic nemerteans been found in protected harbors, gulfs, or bays, even when these have a considerable depth. All species appear to have their habitat limited to the open oceans, although the distance from land may not be many miles. Specimens of *Nectonemertes pelagica* are reported by Cravens and Heath ('06) to have been taken on a fishing-line at a distance of only ten miles from shore. But the water at that distance had a depth of 800–1100 meters.

It seems reasonable therefore to look upon all the pelagic nemerteans as truly bathypelagic, or mesoplanktonic, organisms, living far beneath the surface of the open oceans. Here they swim slowly to and fro or float idly with a very slight muscular effort. For their bodies are composed so largely of gelatinous parenchyma that it is of a specific gravity but little greater than that of the surrounding water. Their bodies, furthermore, are so constructed that their position can be maintained with a minimum expenditure of energy, being flattened horizontally, with very thin lateral margins, and having the posterior extremity very flat and often broadened terminally to form a very perfect caudal fin. The musculature of the body is very weak anteriorly, but increases toward

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[1] Recent studies indicate that at least one of the species recorded from the Pacific is specifically distinct, although closely related to *N. mirabilis*.

the posterior end, showing that, as in the vertebrate counterpart, the fish, the caudal region is mainly concerned in locomotion. Indeed, as is shown by the photographs on Plate 3, the configuration of the body of Nectonemertes is almost identical with that of certain fishes.

Strangely enough, these species appear to be almost devoid of the specialized sense-organs, such as ocelli, otocysts, cerebral sense-organs, frontal organs, and lateral sense-organs, which are found in littoral species. The absence of ocelli is quite comprehensible in animals living at such depths, but cerebral sense-organs have been supposed to be of the greatest importance to the nemertean's welfare, for, although their function is not certainly known, they occur without exception in all other groups of nemerteans.

Bürger ('09) and Brinkmann ('16) have found peculiar sense-organs in the head of Balaenanemertes and Pelagonemertes respectively which they consider to be rudimentary ocelli, and integumentary sense-organs of a simple type occur in nearly all forms, but there is no evidence as to their functions.

Finally there should be mentioned the remarkable structures associated with the dorsal nerve in Neuronemertes, described in this report. The nature of these organs is likewise entirely problematical.

Food

Few data are available regarding the food of these organisms, but this is hardly surprising in consideration of the relatively small number of specimens which have been examined in this respect. With one exception, the digestive systems of all the specimens studied in preparation of this report have been empty. The specimen to which reference is made was a specimen of *Pelagonemertes brinkmanni* which had in one of its anterior pair of intestinal diverticula a small, oval, multicellular organism, but it is not known whether this had been ingested as food or whether it was an internal parasite.

In one specimen of *Nectonemertes mirabilis* Brinkmann ('17a) found a small crustacean in the intestine, proving that at least a portion of the food is of the same general nature as that of littoral species.

The nearest littoral relative of the pelagic nemerteans is Drepanophorus, and as this is truly carnivorous in its habits, feeding on large annelids and the like, it may be assumed that these forms likewise secure relatively large invertebrates for food.

Natural Enemies

Nor is anything as yet known in regard to the natural enemies of the pelagic nemerteans. It seems quite possible that such enemies have a large influence on the species, for in spite of most remarkable adaptations to ensure their reproduction, these worms form but a very sparse population in any region. An insufficient food-supply or other adverse environmental condition may be equally or more influential in limiting their reproduction.

Parasites

In the littoral nemerteans unicellular parasites are of frequent occurrence, imbedded in the tissues of nearly all the organs of the body. They occur most commonly in the epithelium of the digestive system and in the body-parenchyma, but are not uncommon in the brain and in the gonads. Although they have been but little studied as yet and their life-histories are unknown, they have been referred to several groups of Sporozoa. Multicellular parasites have also been recorded a number of times.

In the bathypelagic forms small unicellular parasites, apparently Sporozoa, have been described and figured by Brinkmann ('17a) in the eggs of *Nectonemertes primitiva* and in the brain and parenchyma of *Parabalaenanemertes fusca.*

Habits

Brinkmann ('17a) has recorded many interesting observations on the activities of living individuals of *Nectonemertes mirabilis.* Although these individuals had been brought up from a thousand meters below the surface where the unvarying temperature is from 4° to 6°C., as the case may be, and where the water-pressure is almost inconceivably great, yet the worms have such a great vitality that they swim about freely when placed in a glass of sea-water. Indeed, an individual that was found in the meshes of a net more than a half-hour after being thrown upon the deck swam in a lively manner when placed in sea-water.

In swimming the worms were observed to strike the water violently with the caudal fin, at the same time making undulating movements of the body. They can swim with the body either vertical or horizontal, and make rather rapid progress. Even when the body is badly mutilated they are able to swim for a considerable time before death ensues.

Moseley (1871) also describes the active swimming of an individual of *Pelagonemertes moseleyi* after it had been brought from a great depth.

GEOGRAPHICAL DISTRIBUTION.

The accompanying chart (Plate 30) shows that pelagic nemerteans have been collected in all the large oceans with the exception of the Antarctic. The stations indicated, however, furnish no evidence that these organisms are more abundant in those particular localities than elsewhere in the open oceans, but the conclusion to be drawn is that these stations indicate somewhat roughly the regions where pelagic explorations have been most thorough. Future collections of the bathypelagic organisms in the oceanic waters in the other parts of the world may reasonably be expected to yield an equal abundance of these worms, and prove them to be not only of world-wide distribution but to form a fairly numerous population in the deeper layers of water.

It will be noticed at once that the pelagic nemerteans are found only on the high seas, in no case occurring in the more protected gulfs and bays, where the explorations are so complete that they would certainly have been discovered if present. As explained in the preceding chapter, their absence in such situations is due to the absence there of the particular water-layers in which these forms are able to live.

On the earlier oceanic exploring expeditions the principal effort was made to secure specimens of the organisms at or near the surface of the water and upon the floor of the oceans, samples of the intervening life, except the larger forms, such as fishes, having been secured only accidentally during the ascent or descent of the fishing- or dredging-apparatus. The more recent investigations, as mentioned in the introduction to this report, have made a special attempt to secure the smaller bathypelagic organisms, and where these surveys have been made nemerteans were frequently found. And since the North Atlantic has received by far the greatest amount of attention, it is there that the chart appears to show a richer bathypelagic nemertean fauna than elsewhere in the world. To what extent, if any, such may actually be the case only future investigations can determine.

The group of stations off the eastern coast of the United States shows the regions where *Nectonemertes mirabilis* was taken by the expeditions of the United States Fish Commission; a number of those in the central and eastern North Atlantic indicate the course of the deep-sea explorations by the Prince of Monaco; the more numerous stations in the North Atlantic show in a general way the regions where the Michael Sars deep-sea expedition made its collections under the auspices of the Norwegian government.

In the South Atlantic and Indian Oceans are the stations where the German South Polar expedition and the German Tiefsee expedition secured pelagic nemerteans, while in the North Atlantic and Arctic Oceans the stations are indicated at which the same or additional species were collected by Danish, Swedish, and other deep-sea expeditions.

The stations in the equatorial Pacific off the northwest coast of South America show a portion of the routes followed by the U. S. Fish Commission steamer Albatross, and those in the North Pacific follow the course of the Northwest Pacific expedition, as described more fully in the introductory chapter of this report.

The chart further shows that the following twenty-eight out of a total of forty-seven described species are known from only a single collecting station.

1.	*Protopelagonemertes hubrechti*	North Atlantic
2.	*Plotonemertes adhaerens*	North Atlantic
5.	*Planktonemertes vanhoffeni*	South Atlantic
6.	*Mononemertes sargassicola*	North Atlantic
7.	*Crassonemertes robusta*	North Atlantic
8.	*Crassonemertes (?) rhomboidalis*	North Atlantic
9.	*Mergonemertes woodworthii*	Indian Ocean
10.	*Neuronemertes aurantiaca*	Tropical Pacific
11.	*Bürgeriella notabilis*	North Atlantic
12.	*Paradinonemertes drygalskii*	North Atlantic
16.	*Dinonemertes mollis*	Tropical Pacific
17.	*Planonemertes lobata*	Tropical Pacific
18.	*Plionemertes plana*	Tropical Pacific
20.	*Chuniella lanceolata*	North Atlantic
21.	*Chuniella agassizii*	Tropical Atlantic
22.	*Chuniella pelagica*	Indian Ocean
23.	*Chuniella (?) elongata*	North Atlantic
25.	*Nectonemertes japonica*	North Pacific
30.	*Proarmaueria pellucida*	Northwest Pacific (Sea of Okhotsk)
31.	*Cuneonemertes gracilis*	Tropical Pacific
34.	*Pelagonemertes joubini*	Equatorial Pacific
35.	*Pelagonemertes moseleyi*	Northwest Pacific
37.	*Gelanemertes richardi*	North Atlantic
40.	*Probalaenanemertes wijnhoffi*	North Atlantic
41.	*Balaenanemertes chuni*	Indian Ocean
44.	*Balaenanemertes choresi*	North Atlantic
46.	*Balaenanemertes hjorti*	North Atlantic
47.	*Balaenanemertes lata*	North Atlantic

The following four species are recorded from two localities each:—

15.	*Dinonemertes grimaldii*	North Atlantic
32.	*Natonemertes acutocaudata*	North Atlantic
39.	*Parabalaenanemertes (?) zonata*	North Atlantic
45.	*Balaenanemertes grandis*	North Atlantic

Each of the five following species has been collected from three localities:—

3.	*Pendonemertes levinsini*	North Atlantic
13.	*Dinonemertes investigatoris*	North Atlantic and Indian Ocean
28.	*Nectonemertes primitiva*	Equatorial and North Atlantic
38.	*Parabalaenanemertes fusca*	North Atlantic
42.	*Bolaenanemertes musculocaudata*	North Atlantic

Four of the species, as follows, were each taken at four different stations:—

4.	*Planktonemertes agassizii*	Tropical Pacific
14.	*Dinonemertes alberti*	Arctic Ocean
26.	*Nectonemertes pelagica*	Tropical to North Pacific
29.	*Armaueria rubra*	North Atlantic

Two species, 27, *Nectonemertes minima*, from the North and South Atlantic, and 43, *Balaenanemertes lobata*, from the North Atlantic, were each taken at six localities, and the two following from seven: 33, *Pelagonemertes rollestoni*, from the equatorial Atlantic to northern and southeastern Indian Oceans, and 36, *Pelagonemertes brinkmanni*, from the northern Pacific. 19, *Phallonemertes murrayi* is at present known from eight different stations in the North Atlantic, while 24, *Nectonemertes mirabilis*, has been collected much oftener than any other pelagic nemertean, being thus far recorded from thirty-one collecting stations covering the entire extent of the North Atlantic from 30° North. Of the nine families in which the twenty-five genera and forty-seven species may be placed, three, Protopelagonemertidae, with three genera, Bürgeriellidae, with one genus, and Phallonemertidae, with one genus, have been found only in the North Atlantic. Representatives of the family Planktonemertidae are known to occur in the North and South Atlantic, equatorial Pacific, and Indian Oceans; the Dinonemertidae are found also in the North Atlantic, Pacific, and Indian Oceans, while the Chuniellidae are known only from the North Atlantic and Indian Oceans. The Nectonemertidae are recorded from both sides of the North Pacific, from the American side of the South Pacific, throughout the North Atlantic and on the African side of the South Atlantic, occurring wherever pelagic nemerteans have been collected, except in the Arctic and Indian Oceans. One genus of the Armaueriidae lives in the North Atlantic and another on the Asiatic side of the Pacific, while the Pelagonemertidae, with seven genera, occur in all the explored oceans, except, possibly, the Arctic.

The most widely distributed species are *Dinonemertes investigatoris*, from the North Atlantic and Indian Oceans; *Nectonemertes mirabilis*, throughout the North Atlantic; *N. pelagica*, in the Pacific from 52 degrees North to 12 degrees South of the equator; *N. minima* crosses the equator in an even more extended distribution in the Atlantic, ranging from 57 degrees North to 35 degrees South;

while *N. primitiva* has a parallel but less extended north to south range. *Pelagonemertes rollestoni* extends from the equator in the Atlantic, along the coast of Africa to 4 degrees North in the Indian Ocean and to 50 degrees South of the equator, in a region where the Indian and Pacific Oceans meet.

The North Atlantic thus has but two pelagic species recorded from the American side, while fourteen species are known to occur in the middle Atlantic and seventeen on the European-African side. The South Atlantic has four species on the African side, but none have been found on the American side, nor have any of these nemerteans been taken from off the east coast of Africa, although four species occur in the middle Indian Ocean and two on the Australian side. From north of the Arctic circle only *Dinonemertes alberti* is as yet known. In the North Pacific four species have been collected on the American side and three on the Asiatic side, while six species have been found on the South American side of the equatorial Pacific, but none on the Australian side.

The reader can hardly fail to realize how inadequate is the present knowledge concerning the geographical distribution of this group of worms, and be impressed with the opportunities awaiting future investigations into the pelagic life of those vast areas of the oceans as yet unexplored or but superficially explored. He can but imagine the multitude of forms, equally strange with those here recorded, that await their discoverers.

CLASSIFICATION.

Brinkmann ('17) proposes the division of the order Hoplonemertea, in which the proboscis bears an armature, into two suborders: — 1. Monostylifera, those in which the basis is provided with a single stylet; and 2. Polystylifera, those in which the basis is provided with several stylets. He proposes the further division of the Polystylifera into two tribes, as follows: —

1. *Reptantia.* To include the bottom-living forms in which cerebral sense-organs, nephridia, and rhynchocoel diverticula are present, and which have interdiverticular gonads throughout the intestinal region in both sexes. This tribe contains the single family Drepanophoridae, with the genera Drepanophorus and Uniporus.

2. *Pelagica.* Free-swimming forms, which lack cerebral sense-organs, nephridia, and rhynchocoel diverticula and in which the spermaries are limited to the anterior end of the body.

Up to the present time[1] no forms have been discovered which unite these two tribes very closely, although the pelagic genus Protopelagonemertes has several features in which it resembles the littoral forms. Brinkmann has further proposed the establishment of nine families to include the eighteen genera and thirty-seven species of pelagic nemerteans which he recognized. These families are in some cases founded on peculiarities which appear to be of such minor importance that they are of hardly more than generic value, instead of being fundamental characteristics suitable for family diagnoses. Undue emphasis seems to be placed on the position of the spermaries, for while that feature is certainly of importance in determining the relationships of the various genera and species, it is difficult of practical application because in so many species the female sex only is as yet known.

Although the writer believes that all the species of pelagic nemerteans at present known could be placed in a smaller number of families than the nine proposed by Brinkmann, he nevertheless follows that investigator's classification in this report. So great has been the increase in the number of new forms

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[1] Since this statement was written Gerard Stiasny-Wijnhoff ('23) has reported the discovery of a nemertean collected by the SIBOGA expedition in water having a depth of 883 meters, which exhibits a combination of characters linking it both with the Reptantia and with the Pelagica. This new form, *Siboganemertes weberi*, from south of Timor, is made the type of a subtribe, Archireptantia, while all of the previously known Reptantia are placed in the subtribe Eureptantia.

from the Michael Sars expedition alone, that it must be expected that future collections will greatly increase the number known at present. Seven new genera and eight new species are added in the present report, and as yet but a minute fraction of the oceans of the world have been explored with apparatus suitable for the collection of bathypelagic organisms. Hence any attempt at classification must at this time be provisional, as Brinkmann himself explains. The general scheme of his classification appears to be sound, however, and it seems desirable to avoid introducing in this report changes which may cause confusion and which may themselves later prove untenable.

KEY TO THE FAMILIES.[1]

Order HOPLONEMERTEA, Suborder POLYSTYLIFERA, Tribe PELAGICA.

A. Posterior end of body not clearly differentiated into a caudal fin .... B.
AA. Posterior end of body forming a flattened caudal fin .... D.
  B. Musculature of proboscis-sheath of interwoven circular and longitudinal fibers. *Protopelagonemertidae.*
  BB. Circular and longitudinal muscles of proboscis-sheath in separate layers .... C.
    C. Intestinal diverticula numerous, closely appressed; not much branched and without distinct ventral branch .... *Chuniellidae.*
    CC. Intestinal diverticula few, widely separated and divided repeatedly into numerous, slender branches .... *Bürgeriellidae.*
      D. Body slender .... E.
      DD. Body broad and flat .... F.
        E. Proboscis-sheath about three fifths as long as body; sexually mature males with slender, tubular, protruding genital papillae .... *Phallonemertidae.*
        EE. Proboscis-sheath nearly as long as body; adult males with well-developed tentacles. *Nectonemertidae.*
          F. Dorsal vessel extends almost the entire length of body .... G.
          FF. Dorsal vessel ends blindly in rhynchocoel a short distance back of brain. *Pelagonemertidae.*
            G. Dorsal vessel enters rhynchocoel for a short distance behind brain, then passes beneath proboscis-sheath to posterior end of body; dorsal anastomosis of cephalic vessels present .... H.
            GG. Dorsal vessel remains beneath proboscis-sheath the entire length of body; dorsal anastomosis of cephalic vessels absent .... *Armaueriidae.*
              H. Intestinal diverticula much branched .... *Planktonemertidae.*
              HH. Intestinal diverticula somewhat lobed distally, but without distinct branches. *Dinonemertidae.*

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[1] The genus Gelanemertes is not included in this key, since the internal organization of the single described species is so little known that its family relationship is at present doubtful.

SYSTEMATIC DESCRIPTION OF FAMILIES, GENERA, AND SPECIES.

PROTOPELAGONEMERTIDAE Brinkmann.

Bergens mus. skrift., 1917, ny raek., 3, no. 1, p. 178.

Bathynemertidae BRINKMANN, Rept. Michael Sars, 1917, **3**, p. 4; Bergens mus. skrift., 1917, ny raek. **3**, no. 1, p. 7.

Body rather slender and not much flattened; without caudal fin; intestinal diverticula with ventral branch beneath lateral nerve-cord; spermaries in two simple rows behind the brain. The three genera may be separated as follows: —

A. Mouth and proboscis-opening united; body tapered at both ends; proboscis-sheath reaches posterior end of body . . . . . *Protopelagonemertes.*
AA. Mouth and proboscis-opening separate . . . . . B.
  B. Nerve-cord muscle absent; proboscis-sheath three fourths the length of body; male with pair of large glandular organs on ventral side of body . . . . . *Plotonemertes.*
  BB. Nerve-cord muscle well developed, proboscis-sheath but half the length of body. *Pendonemertes.*

PROTOPELAGONEMERTES Brinkmann.

Bergens mus. skrift., 1917, ny raek., 3, no. 1, p. 178.

Bathynemertes BRINKMANN (*non* Laidlaw), Rept. Michael Sars, 1917, **3**, p. 4; Bergens mus. skrift., 1917, ny raek., **3**, no. 1, p. 7.

In this genus the body is narrowed both anteriorly and posteriorly, and but little flattened; mouth and proboscis-opening are united; rhynchocoel extends nearly the entire length of the body, its walls being composed of interlaced circular, or spiral, and longitudinal muscles.

This genus is of particular interest in that the anatomical features on which it is based resemble more closely those of Drepanophorus, the littoral form apparently most closely related to the pelagic nemerteans and therefore looked upon as the littoral representative of the stock from which the pelagic nemerteans have been derived. Siboganemertes is perhaps an intermediate type (p. 98).

1. PROTOPELAGONEMERTES HUBRECHTI Brinkmann.

Bergens mus. skrift., 1917, ny raek., 3, no. 1, p. 178.

Bathynemertes hubrechti BRINKMANN, Rept. Michael Sars, 1917, **3**, p. 4; Bergens mus. skrift., 1917, ny raek., **3**, no. 1, p. 7, pl. 2, fig. 1–9.

Figure 51–53.

Only one specimen of this primitive type is known. This resembled some of the littoral species of Drepanophorus in form, being 56 mm. in length and 10 mm. wide in the middle portions of the body. The anterior end is narrowed rounded, while the posterior end is distinctly pointed (Figure 51). Anteriorly the body is almost circular in cross section but it becomes gradually flattened posteriorly. The circular and longitudinal muscular layers of the body-walls, although thin, are better developed than in most pelagic forms, while the dorsoventral fibers are correspondingly reduced.

Proboscis-sheath and proboscis. The rhynchocoel extends nearly to the posterior end of the body. Its two muscular layers are made up of interwoven longitudinal and circular fibers continuous with those of the proboscis-wall at the point attachment in the brain-region. The proboscis has twenty-nine nerves arranged symmetrically in the middle of a very thick, longitudinal, muscular layer. These form a distinct nerve-ring in the stylet-region. The deeply curved basis bears numerous sharply pointed, conical stylets.

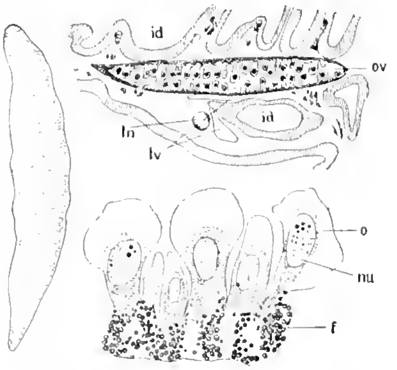

FIG. 51–53.—*Protopelagonemertes hubrechti* Brinkmann. Fig. 51, dorsal surface of type specimen. × ca. ¾. Fig. 52, portion of section of body of same species, showing the elongated ovary (*ov*) with its numerous ova; *ln*, lateral nerve; *lv*, lateral blood-vessel; *id*, intestinal diverticula. × 14. Fig. 53, portion of wall of ovary, showing the ova (*o*), each with a large nucleus (*nu*) and a long protoplasmic process extending into the follicular syncytium (*f*). × 80. (After Brinkmann, 1917a).

The posterior end of the proboscis is continued into a muscular band which passes through the dorsal wall of the proboscis-sheath a few millimeters in front of its posterior end and becomes inserted in the dorsal body-walls. This forms a very strong retractor.

Digestive system. The mouth and proboscis open together in small terminal depression. The mouth opens directly into a voluminous stomach with convoluted walls and this leads into the dorsoventrally flattened pylorus. There are about forty pairs of large and profusely branched intestinal diverticula, with several smaller ones behind the posterior nerve-anastomosis. The branches extend on both dorsal and ventral sides of the lateral nerves. The caecum is also voluminous, with five pairs of large, much branched diverticula and a small fork or pair of rudimentary diverticula at its anterior end.

Vascular system. The dorsal vessel enters the rhynchocoel shortly after its origin from the ventral cephalic anastomosis. About 10 mm. farther back it leaves the proboscis-sheath, beneath which it continues to its anastomosis with the lateral vessels above the posterior end of the intestine.

Nervous system. The brain and lateral nerves show few deviations from other pelagic forms. There are paired dorsal, lateral, and ventral branches from the lateral nerves, with frequent anastomoses from the two sides beneath the intestine. The dorsal nerve is very small.

Reproductive organs. The single known specimen of this species was a female with numerous large, but rather immature, ovaries, each with many ova (Figure 52). The ova project into the ovarian cavity, with long nutritive processes imbedded in a thick peripheral syncytium of small follicle-cells (Figure 53).

Geographical distribution. North Atlantic Ocean (Lat. 48° 29′ N., Long. 13° 55′ W.); one specimen from about 2000 meters; pelagic.

PLOTONEMERTES Brinkmann.

Rept. Michael Sars, 1917, **3**, p. 5; Bergens mus. skrift., 1917, ny raek., **3**, no. 1, p. 12.

Mouth and proboscis-opening separate; body but little flattened; male with a pair of integumental glandular organs near posterior end of ventral surface.

2. PLOTONEMERTES ADHAERENS Brinkmann.

Rept. Michael Sars, 1917, **3**, p. 5; Bergens mus. skrift., 1917, ny raek., **3**, no. 1, p. 12, pl. 4, fig. 1–14, Figure 1.

Figure 54, 55.

But one specimen of this species is as yet known. This was 30 mm. long, by 9 mm. in greatest width and 4 mm. or less in thickness. The anterior end of the body is club-shaped in the specimen with everted proboscis (Figure 54).

Glandular organs. The male is provided with a pair of large glandular organs, each consisting of a horseshoe-shaped area of highly specialized and convoluted integument near the posterior end of the ventral surface, involving also the muscular and basement-layers of the underlying body-walls (Figure 55). Brinkmann suggests that these may be adhesive appendages developed in the male to enable him to cling to the female while the eggs are fertilized.

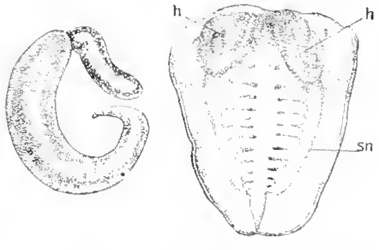

Fig. 54, 55.—*Plotonemertes adhaerens* Brinkmann. Fig. 54, type specimen with everted proboscis. × 1.3. Fig. 55, ventral side of posterior end of body, showing the pair of integumental glandular organs (*h*), and posterior portions of intestinal canal, and lateral nerves (*sn*). × 5. (After Brinkmann, 1917).

Alimentary canal. The intestine has more than fifty pairs of large diverticula with both ventral and dorsal branches, and the caecum six pairs.

Proboscis-sheath and proboscis. The proboscis-sheath is limited to the anterior three fourths of the body. The proboscis has twenty-seven nerves and a rather sharply curved basis bearing more than five stylets. The retractor is attached to the dorsal wall of the rhynchocoel about 1 mm. in front of the posterior end of the latter.

Nervous system. A pair of subdorsal nerves arises from the posterior borders of the dorsal ganglia, and extends posteriorly just internal to the musculature of the body-walls on either side of the median line. They connect by frequent branches both with the dorsal and with the lateral nerves.

Reproductive organs. The male has eight to eleven spermaries in a single row on each side of the head and extending back to the first pair of intestinal diverticula. Female unknown.

Geographical distribution. The single specimen thus far secured came from the North Atlantic (Lat. 47° 34′ N., Long. 43° 11′ W.). Pelagic at a depth of about 2000 meters.

PENDONEMERTES Brinkmann.

Rept. Michael Sars, 1917, **3**, p. 5.

Mouth and proboscis-opening separate; body rounded anteriorly, flattened behind; proboscis-sheath limited to anterior half of body; lateral nerve with fibers from both dorsal and ventral ganglia, but making a single fibrous core; nerve-cord muscles well developed.

3. PENDONEMERTES LEVINSENI Brinkmann.

Rept. Michael Sars, 1917, **3**, p. 5; Bergens mus. skrift., 1917, ny raek., **3**, no. 1, p. 17, pl. 4, fig. 15–22, pl. 5, fig. 1–3, Figure 2–4.

Figure 56, 57.

The three known specimens of this species were 20 to 26 mm. long, with a width of 5 to 6 mm. (Figure 56). There are sixteen (or more) proboscidial nerves. The armature of the proboscis consists of a small, crescentic basis bearing numerous stylets. The intestine bears thirty to forty pairs of large diverticula with dorsal and ventral branches, each with several lobes. The caecum is provided with three pairs of large, branched diverticula which extend forward to the brain. The nerve-cord muscle is very large (Figure 57). The dorsal nerve is small.

Reproductive organs. The three known specimens were all females with twenty to twenty-four pairs of ovaries. Only three or four of the numerous eggs found in the young ovary reach maturity, but these become of large size and rich in yolk. The others are absorbed as food-material to furnish yolk for those which mature.

Geographical distribution. North Atlantic (Lat. 35°–50° N., Long. 7°–11° 23′ W.). Pelagic at a depth of about 1000 to 2260 meters.

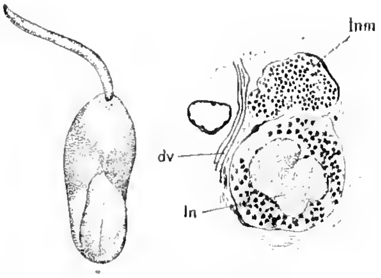

Fig. 56, 57.—*Pendonemertes levinseni* Brinkmann. Fig. 56, female from ventral surface. × 1. Fig. 57, portion of transverse section showing the nerve-cord muscle (*lnm*) in contact with the lateral nerve (*ln*); *dv*, dorsoventral muscles. × 80. (After Brinkmann, 1917a).

PLANKTONEMERTIDAE Brinkmann.

Bergens mus. skrift., 1917, ny raek., **3**, no. 1, p. 22.

Body very broad and in most cases much flattened; posterior end of body very flat and usually differentiated into a caudal fin; proboscis-sheath of interlaced fibers; intestinal diverticula much divided, usually with ventral branch; spermaries in two longitudinal groups or rows immediately behind the brain.

Three genera have been previously assigned to this family to which the new genus Neuronemertes, described in this report, evidently belongs. A fifth genus, to which the name Mononemertes may be given, is necessitated for a species briefly described as Planktonemertes by Joubin ('06) and is provisionally included in this family. These genera may be distinguished by the following key:—

A. Body very flat; mouth and proboscis have a common opening. . . . . B.
AA. Mouth and proboscis-opening separate . . . . C.
  B. Body broad and very flat; without distinct caudal fin . . . *Planktonemertes.*
  BB. Body broad in middle third, narrowed at both extremities; rounded anteriorly; with distinct caudal fin . . . . *Mononemertes.*
    C. Body short, broad, and thick; proboscis-sheath nearly as long as the body . . *Crassonemertes.*
    CC. Body rather broad and flat; proboscis-sheath not more than three fourths as long as the body . D.
      D. Proboscis-sheath about half the length of body; dorsal nerve without metameric appendages. *Mergonemertes.*
      DD. Proboscis-sheath three fourths as long as body; dorsal nerve with large metameric appendages . . . . *Neuronemertes.*

PLANKTONEMERTES Woodworth.

Bull. M. C. Z., 1899, **35**, p. 2.

Body broad and very flat; mouth and proboscis-opening united; proboscis-sheath extends almost the entire length of body; musculature of proboscis-sheath of interwoven fibers; intestinal diverticula very numerous, much branched, with ventral branch beneath lateral nerve; lateral nerve has but a single fibrous core; spermaries in two elongated groups or irregular rows posterior to brain.

Two species have thus far been fully described anatomically, in addition to several placed in this genus by Joubin, from a superficial examination only. The fully described species are: —

A. Intestinal caecum with 8 pairs of diverticula; stylet-basis not sharply curved, ligulate, armed with about 12 stylets. . . . . *P. agassizii.*

AA. Intestinal caecum with 5 pairs of diverticula; stylet-basis sharply curved, crescentic. *P. vanhöffeni.*

None of the six forms placed in this genus by Joubin ('06) appears to agree with the generic diagnosis as amended by Brinkmann.

4. PLANKTONEMERTES AGASSIZII Woodworth.

Bull. M. C. Z., 1899, **35**, p. 2, pl.—, fig. 1–4 (*non* Bürger); Coe, Bull. M. C. Z., 1905, **47**, p. 304; Brinkmann, Bergens mus. skrift., 1917, ny raek., **3**, no. 1, p. 22.

Plate **1**, fig. 1, 1a; Plate **5**, fig. 34–43; Plate **6**, fig. 44–49; Plate **7**, fig. 50–54; Plate **8**, fig. 55–60; Plate **13**, fig. 90, 91.

Figure 1, 13, 18, 23, 48.

Five specimens of this species were described by Woodworth ('99) in his preliminary paper. Serial sections of three of these were made by him, but as other duties prevented a study of the sections the entire material was turned over to the present writer for investigation. These specimens were collected in 1891 during the expedition of the U. S. Fish Commission steamer ALBATROSS, in charge of Alexander Agassiz, off the west coasts of Central and South America to the Galapagos Islands. Mr. Agassiz made notes on the color and appearance in life and made a colored drawing of the living animal (Plate **1**, fig. 1).

Shape of body. The living worms are elliptical in shape, with very thin, parallel, undulating sides and are smoothly rounded at both anterior and posterior ends. The extreme flatness of the body gives the animal the general appearance of a planarian rather than a nemertean.

Size. The measurements given for the individual specimens show that the mature worms vary from 14 to 47 mm. in length, and from 5.5 to 16 mm. in width, with a thickness of only 1.5 to 2 mm. The average length is from two and one half to three and one half times as great as the width.

Color. The general color of the living animals is light scarlet, with shades of orange, red, or pink. The proboscis, intestinal canal, and other internal organs appear in the translucent, living animal as bands of deeper color. Plate **1**, fig. 1

represents Mr. Agassiz's drawing from life of the specimen represented in fig. 37 (Plate 5) and shows in the living animal the positions of proboscis, lateral nerves, and diverticula intestinal. Figure 35, 36, 37 (Plate 5) were drawn by Dr. Woodworth from the specimens after they had been cleared in oil. The alcoholic material shows no trace of pigment, the colors having been completely extracted by the preserving fluids.

Owing to the extreme thinness and translucence of the animal, a large part of the internal structure can be recognized even in the uncleared condition when viewed by transmitted light.

After careful drawings of the body were made, four of the specimens were cut in serial sections representing all three planes of the body. A detailed study of this material reveals a number of features which supplements to some extent our previous knowledge of the morphological features of the pelagic nemerteans.

Integument. As in most other pelagic forms, the epidermis was mostly dislodged during capture and preservation, being found in the sections only in isolated patches, particularly on the ventral surface. Where present, gland-cells of the two usual types could be distinguished in addition to ciliated cells of the usual form. The flask-shaped gland-cells are expanded at their basal ends and are filled with a finely granular secretion, while in the oval type the cell is filled with more coarsely granular refractive bodies varying in size and shape.

Body-walls. The basement-layer is everywhere thick, as is the case with many pelagic species. The external, circular musculature of the body-walls is remarkably thin, consisting of but a single layer of fibers closely applied to the basement-membrane, while the deeper, longitudinal muscles form a thick zone many layers in depth (Plate 5, fig. 39). The longitudinal musculature is slightly thicker on the ventral than on the dorsal side of the body, being most highly developed at a point about a third of the distance from median line to lateral margin. Toward the lateral borders of the body, the muscular layer becomes gradually thinner, until at the extreme margins it may be so reduced as to consist of a thin sheet only a single fiber in thickness (Figure 18). The longitudinal muscles are furthermore grouped into bundles more or less sharply separated from one another by the gelatinous tissues. The bundles of muscles project as ridges into the general parenchyma, the inner margin of the musculature appearing sinuous and scalloped in cross section, the indentations representing the limits of the primitive bundles (Figure 18).

Numerous well-developed bands of dorsoventral muscles lie in the parenchyma of the interdiverticular spaces. They pass directly between the dorsal and ventral body-walls, most of them passing through the longitudinal musculature to become interlaced among the circular muscle-bundles (Plate 5, fig. 43). This interlacing of the dorsoventral and circular muscles takes place in an anteroposterior direction as can be seen by comparing longitudinal and transverse sections. In this manner the dorsoventral fibers are so intimately incorporated with the body-walls that they are capable of a powerful contraction resulting in a flattening of the body in the act of swimming or in peristaltic movements affecting the vascular and digestive systems.

Parenchyma. The body-parenchyma, which fills all the space not occupied by the organs, consists of a delicate felt-work of excessively fine fibers with a homogeneous hyaline and gelatinous matrix filling the meshes or spaces between them. Scattered through the parenchyma are spherical cells with large nuclei. These occur singly or sometimes in groups of from four to ten.

Rhynchodeum. There is but a single opening on the anterior margin of the head, and this leads directly into a short chamber (atrium) from the posterior end of which the rhynchodeum opens dorsally and the oesophagus ventrally (Plate 5, fig. 49). It is probable that in certain states of contraction, as in the eversion of the proboscis or in the process of ingestion, the atrium would largely disappear by the encroachment of the other organs.

The epithelial lining of both the rhynchodeum and the anterior proboscis-chamber has been dislodged over the greater portion of the surface in all the specimens sectioned.

Proboscis-sheath. The proboscis-sheath extends fully nine tenths the length of the body and the proboscis is attached by the slender retractor-muscles to the inner dorsal wall of the sheath a short distance in front of its posterior extremity (Plate 6, fig. 34). The attachment of the retractor-muscles is accomplished by a direct interlacing of its muscular strands with the muscle-bundles of the sheath. In normal eversion (Plate 5, fig. 34), the posterior chamber of the proboscis is enormously lengthened and attenuated; when spasmodically ejected, the retractor-muscles are ruptured some distance from the wall of the sheath, leaving, as in Nectonemertes, Planonemertes, and some other forms, a broken strand of tissue, including the posterior tip of the proboscis itself, still attached to the wall of the sheath.

The rhynchocoel is lined with a flattened epithelium resting upon a delicate basement-membrane. The musculature of the sheath consists of interwoven circular, longitudinal and diagonal fibers, the whole making a very thick muscular cylinder, particularly in the anterior and middle portions. The innermost fibers are circular and in the extreme anterior portion of the sheath they form a more or less continuous layer. External to the circular fibers is a system of longitudinal muscles and outside of this a double layer of diagonal or spiral fibers which cross one another at an angle of about forty-five degrees. In the middle part of the sheath the musculature is particularly complicated, the fibers being so intricately interwoven that it is hardly possible to recognize any separate layers, many of the fibers passing spirally outward from the innermost to the outer parts of the musculature. These bind the entire system into a firmly knit tissue of fibers. Toward the posterior end of the sheath the musculature consists of three more or less distinct layers, the longitudinal fibers having become segregated into a rather definite layer between the other two sets of fibers. There will thus be found an inner circular layer, a middle longitudinal layer, and an outer layer of circular or spiral fibers.

Proboscis. The anterior, papilliferous chamber is provided with thick muscular walls, but with only a thin basement-layer (Plate 6, fig. 44). The middle chamber, bearing the armature, is indistinctly separated from the anterior chamber, while the posterior chamber has a relatively thin muscular wall enclosing a thick layer of closely packed columnar gland-cells (Plate 6, fig. 45).

Figure 34 (Plate 5) shows the remarkable length which the proboscis attains in this species, for although everted for a length exceeding that of the entire body, it still remains attached to the sheath at a point (*x*) about four fifths of the distance from anterior to posterior end of body. When it is fully everted it must, therefore, be at least three times as long as the entire body.

The proboscis is attached to the anterior end of the proboscis-sheath by a strong ring of muscles situated immediately anterior to the brain (Plate 5, fig. 42). This ring of insertion is held firmly in place among the other tissues of the head by a strong set of attachment-muscles which pass radially and posteriorly to become interlaced among the muscular bundles of the cephalic wall (Plate 5, fig. 42). These attachment-muscles consist of two broad bands which are attached to the dorsal wall of the head some distance posterior to the brain and two similar bands which extend symmetrically, posteriorly, and toward the ventral surface, one passing on each side of the stomach (Plate 5, fig. 42, *am*) to become inserted in the ventral cephalic wall beneath the posterior end of the stomach. These muscles make a very firm anchorage for the ring of insertion which is obviously subjected to considerable strain when the proboscis is everted and withdrawn.

Anterior chamber. The walls of the anterior chamber are composed of six distinct layers. Beginning on the periphery of the organ in its normal position there is (1) a layer of flattened epithelium, (2) a band of external circular muscles, (3) a system of longitudinal muscles, (4) a layer of internal circular muscles, (5) a basement-layer upon which rests the epithelium lining the proboscis.

The external circular muscles consist of a single sheet of fibers, while the internal circular layer is many fibers in thickness. The longitudinal layer is the strongest of all and constitutes about one half of the thickness of the proboscis-wall. In the midst of this layer about twenty-five large proboscidial nerves are disposed at fairly regular intervals. Between these main nerves is a nerve-plexus with a smaller, secondary nerve about midway between each two principal nerves. In the posterior parts of this chamber these secondary nerves are nearly equal to the primary nerves in size, so that a cross section here shows about fifty separate nerve-bundles (Figure 13).

The rather thick basement-layer underlying the internal epithelium of the proboscis projects into the lumen of the proboscis in spiral or circular folds, thus greatly increasing the area of the epithelial surface, and allowing for extension when the proboscis is everted.

Armature. The lumen of the middle chamber is but slightly demarcated from that of the anterior chamber, but the muscular layers, so sharply defined in the latter, here become interlaced and indefinite. In the wall of this chamber is found a well-developed armature (Plate 6, fig. 45). The stylet-apparatus could be distinguished easily after clearing the middle chamber in oil. It was found to consist of a slender basis which appeared sickle-shaped in optical section, but is actually ligulate, somewhat like the handle of a spoon slightly twisted spirally. The basis is armed with a crowded and irregular row of short stylets. The most perfectly formed stylets are broadly conical and project obliquely from a curved discoidal base (Plate 6, fig. 46–48). Other stylets show little more than the base alone, with but slightly developed conical projection. About twelve of these stylets occupy the outer half of the basis, which projects into the lumen of the anterior chamber when the proboscis is in its normal position, but which lies freely exposed at the very tip of the fully extruded proboscis, to be used as a weapon of offense or defense as occasion requires. Little clusters of similar stylets appear to lie in the proboscis-wall near the basis, but their exact nature could not be determined. A crescentic group of deeply staining glands lies imbedded in the proboscis-walls beneath the basis.

Posterior chamber. In the posterior chamber there is a great reduction in the musculature. The internal circular layer is lacking and the longitudinal layer is much reduced in thickness. The epithelium lining of this chamber consists of slender columnar cells, many of which are crowded with deeply staining, granular secretions. The lumen is very narrow and contains large masses of secretion.

Alimentary canal. The oesophagus is rudimentary, merging into the stomach in front of the brain and without distinct change in its histological character. The stomach extends posteriorly beneath the brain, as a broad canal with convoluted walls, pressing close against the ventral wall of the body for a distance of about 2.5 mm. from the tip of the snout. Here it bends sharply toward the dorsal surface and leads by a small dorsal opening into the pylorus (Plate 6, fig. 49). At the posterior end of the stomach a median blind pouch extends forward about 0.6 mm., or nearly to the brain, as a well-developed gastric caecum. Although this caecum is separated from the stomach by a considerable band of connective tissue there is little doubt that in the act of ingestion both cavities merge into one. The walls of oesophagus, stomach, and gastric caecum are all much convoluted, allowing for an increased secreting surface and also for a great distension of the parts in the process of ingestion. The pylorus, on the other hand, is a straight but flattened tube with a perfectly smooth lining.

Intestinal caecum. The pylorus opens by a longitudinal slit into the dorsal wall of the intestine at a point about 5.5 mm. back of the posterior end of the stomach, and about an equal distance from the anterior end of the intestine. A broad caecum is thus formed which spreads out beneath and beside the pylorus. The caecum is very voluminous and as it extends forward nearly to the posterior end of the stomach (Plate 6, fig. 49), it gives off eight pairs of diverticula which ramify through the body-parenchyma lateral to the proboscis-sheath and well toward the dorsal side of the body. These diverticula are provided with both dorsal and ventral branches resembling in all respects those of the intestine proper. The most anterior pair of diverticula is the largest.

Intestine. The posterior portions of the pylorus are lined with ciliated cells, with only an occasional gland-cell, and this ciliated lining continues for a short distance on the dorsal wall of the intestine as a narrow ciliated band, bordered on each side by the columnar gland-cells of the intestine.

There are at least forty pairs of profusely branched and lobed intestinal diverticula in all the specimens available for study, and more than fifty pairs in most of them. In the anterior and middle portions of the body each diverticulum is divided into a large dorsal branch and a smaller ventral branch. The former is subdivided into many irregular lobes which extend into the parenchyma both vertically and horizontally. The latter extends laterally on the ventral side of the lateral nerve. A transverse section of the body, therefore, shows numerous sections of the diverticula (Figure 12), with relatively little parenchyma between them, while horizontal or sagittal sections (Plate 5, fig. 43) show that the diverticula are very closely crowded and appressed vertically with narrow spaces for the interdiverticular parenchyma in which the peripheral nerves and the dorsoventral muscles are imbedded.

Toward the posterior end of the body the diverticula become smaller and much less branched, the ventral branch disappearing far in front of the caudal fin. Near the rectum only small rudiments of the intestinal lobes remain. The rectum leading to the posterior extremity is very slender, as in related forms. With the full maturity of the ovaries, these organs press against the ventral wall of the body to such an extent as to force the ventral branches of the intestinal diverticula toward the median line, crowding the nerve-cords against the body-wall. In such cases therefore these branches of the diverticula will not be found between the nerve-cord and the body-wall, although such a condition is characteristic of the species.

Vascular system. The cephalic loops of the vascular system are essentially as in other forms, with a broad anterior anastomosis dorsal to the rhynchodeum and a ventral anastomosis just posterior to the ventral brain-commissure. The lateral vessels take a course very much longer than the body because of the presence of distinct convolutions in the interdiverticular spaces. The vessels follow closely the inner border of the lateral nerves which likewise bend sharply toward the median line at each interdiverticular space. But the convolution of the vessels is much greater than that of the nerves for the former make much deeper loops than do the latter.

The dorsal vessel arises as usual from the ventral cephalic anastomosis and passes almost directly into the rhynchocoel. Less than a millimeter posterior to its point of entrance the vessel passes through the ventral wall of the proboscis-sheath, beneath which it continues posteriorly. Behind the posterior end of the proboscis-sheath, the dorsal vessel comes to lie beneath the musculature of the body in the median line, eventually joining the posterior anastomosis of the dorsal vessel on the dorsal side of the rectum.

Nervous system. The brain is of moderate size, with well differentiated dorsal and ventral ganglia. A reconstruction of the brain (Plate 5, fig. 38) indicates the remarkably large size of both dorsal and ventral commissures. From the anterior borders of both dorsal and ventral ganglia many large nerves pass through the cephalic tissues to supply the musculature, integument, and sense-organs of the head.

The lateral nerve-cords are remarkably small as compared with the size of the body as a whole. They are situated about half-way between the lateral margins of the body and the median line. They also lie deep within the body, due to the ventral branch of each intestinal diverticulum which forces itself between the nerve-cord and the ventral wall of the body.

The course of the nerve-cords is very tortuous, for there is a sharp bending toward the median line at each pair of intestinal diverticula.

Transverse sections show that in this species, as Brinkmann ('17a) has already described for *P. vanhoeffeni*, there is but a single fibrous core, and this occupies the central areas of the cord, being bordered dorsally and ventrally by a thick layer of nerve-cells. At each point in the interdiverticular regions where the peripheral nerves issue from the cord, the fibrous core is extended dorsally, laterally, and ventrally to enter the corresponding nerves and the nerve-cells are thereby divided into three groups, as shown in figure 90, 91, Plate 13.

Peripheral nerves. Of the three pairs of peripheral nerves which leave the lateral cords at each of the interdiverticular spaces, the dorsal and ventral are about equal in size, while the lateral is decidedly smaller (Plate 13, fig. 90). Each of these nerves is accompanied by numerous small nerve-cells which form a thin cellular sheath. In this respect this species differs profoundly from Neuronemertes, as described in this report, where the peripheral nerves are accompanied by but a few small cells.

Reproductive organs. All of the specimens at present known are females, the single male specimen previously described (Coe '20) as belonging to this species proving on sectioning to have been erroneously identified.

The ovaries occupy the interdiverticular spaces throughout most of the length of the body. Only in the anterior and posterior ends of the body are they lacking (Plate 1, fig. 1a). They are not found in all the interdiverticular spaces, however, for there are upwards of fifty pairs of diverticula and only twenty to thirty pairs of ovaries. Some of the primitive gonads apparently fail to develop. In one specimen there were only fifteen gonads on one side and twenty on the other. It is possible that in the case of some of the ovaries, the single egg which matures in each may be discharged before the eggs of the other ovaries are fully matured.

The first pair of ovaries lies between the seventh and eighth (last) pair of caecal diverticula. The most posterior pair is formed well anterior to the end of the intestine.

The immature ovaries may have as many as seven or more amoeboid ova suspended in a thin-walled sac lined with a thin layer of protoplasm containing hundreds of nuclei, the whole forming a peripheral syncytium which metabolizes the nutritive materials and provides the yolk for the larger eggs. The mature ovaries on the other hand have but one or, occasionally, two relatively enormous eggs. The others have all been absorbed by the one or two survivors. The diameter of the fully matured ovum is almost equal to the thickness of the body, so that such an egg fills almost the entire space between dorsal and ventral surfaces of the body, measuring from 1.25 to 1.5 mm. in diameter.

The process of ovogenesis is exceptionally well shown in the series of females available for study.

In the earliest stage represented (Plate 7, fig. 50–54; Plate 8, fig. 55), the ovary is a narrow cavity with a distinct lumen and with its long axis extending horizontally between the intestinal diverticula. Its outer wall consists of a thin framework of connective tissue, with widely scattered oval, granular nuclei imbedded in it. Lining the wall is a nearly complete layer of protoplasm without definite cell-boundaries, forming a peripheral syncytium with deeply staining nuclei (Plate 7, fig. 50–54). At numerous places along the wall of the ovary this peripheral protoplasm becomes thickened and the nuclei are crowded into small groups.

Lying freely suspended in the lumen of the ovary, the seven or more amoeboid ova are attached to the peripheral syncytium by protoplasmic processes or pseudopodia (Plate 8, fig. 55). The protoplasmic processes of the ova eventually become broader and shorter and the demarcation between ovum and syncytium is less distinct. The peripheral nuclei often become separated from their neighbours and may be drawn into the protoplasm of the ovum. The size of the ova in this amoeboid stage is from 0.14 to 0.42 mm. in diameter, while their nuclei measure about 0.07 or 0.08 mm., and the primary nucleolus 0.025 mm. in diameter.

The ovary increases in size by the continued increase of the peripheral cytoplasm accompanied by a rapid multiplication of its nuclei. The lumen of the ovary is gradually encroached upon until the ova eventually become imbedded in a syncytial mass which fills the entire ovary (Plate 8, fig. 56–59).

Before the ovary attains this solid condition, the peripheral cytoplasm begins the elaboration of yolk, storing it up in the form of minute yolk-globules. As the elaboration of yolk continues it gradually passes from the peripheral cytoplasm through the pseudopodial processes into the protoplasm of the ovum. At the same time the nuclei of the syncytium begin to degenerate (Figure 48).

The definitive ovum now becomes distinguishable from the other ova partly because of its more central position, but also because the nuclei surrounding it are more densely crowded (Plate 8, fig. 58). Narrow spaces now appear outside the cell-body of the definitive egg, separating the egg from the syncytial mass except where it is connected by pseudopodia. Through these protoplasmic channels the yolk elaborated by the syncytium passes into the egg, which gradually absorbs nearly the entire syncytial mass. Only a thin peripheral layer of yolk-elaborating protoplasm, connected by protoplasmic bridges with the egg, lines the inner wall of the ovary (Plate 8, fig. 60).

Several of the amoeboid ova which remain after the definitive egg becomes differentiated from them, remain in the peripheral yolk-layer near the beginning of the oviduct as abortive ova until the egg is fully matured (Plate 8, fig. 60). The others degenerate in the syncytial mass and are evidently assimilated by it.

The factor determining which one of the amoeboid ova shall become the definitive egg appears to be its position nearest the center of the syncytial mass. If two cells have an equally favorable position both may reach maturity. This would account for those follicles containing two ova.

The oviduct is formed as far as the circular muscular layer of the body-wall in the early yolk-forming stage, but probably does not actually open to the exterior until the egg is ready to be discharged. The oviduct may be situated almost exactly ventrally to the lateral nerve, but is more frequently nearer the lateral margin of the body (Plate 8, fig. 58, 59).

Geographical distribution. This species is as yet known only from the equatorial regions off the west coast of Central and South America and in the general vicinity of the Galapagos Islands. The five specimens collected were taken at four different localities between the equator and 7° 21′′ north latitude and between 79° and 90° west longitude. The precise localities from which the specimens were taken are as follows:—

1. Station 3383; Lat. 7° 21′ 0′′ N., Long. 79° 2′ 0′′ W.; depth 1832 fms. 6.51 A. M., 8 March, 1891. Length 47 mm., greatest breadth 13.5 mm., greatest thickness 3 mm., color orange. Female.

2. Station 3361; Lat. 6° 10′ 0′′ N., Long. 83° 6′ 00′′ W.; depth 1471 fms. 7.33 A. M., 25 February, 1891. Length of body 24 mm., length of everted proboscis 28 mm., greatest breadth 9 mm., greatest thickness 2.5 mm., color orange. Female.

3. Station 3388; Lat. 7° 6′ 0″ N., Long. 79° 48′ 0″ W.; depth 1168 fms. 6.41 A. M., 9 March, 1891. Length 14 mm., greatest breadth 5.5 mm., greatest thickness 1 mm., color orange. Female.

4. Same Station as 3. Length 38 mm., greatest breadth 16 mm., greatest thickness 1 mm., color orange. Female.

5. Station 3406; Lat. 0° 16′ 0″ N., Long. 90° 21′ 30″ W.; depth 551 fms. 6.47 A. M., 3 April, 1891. Length 37 mm., greatest breadth 16 mm., greatest thickness 2 mm., color pink. Female.

In these regions the ocean has a depth of from 551 to 1832 fathoms. These nemerteans, however, were taken in the open trawl and as they are so perfectly adapted for a pelagic life it must be assumed that they were encountered by the net during its upward course at some point between the bottom and the surface.

5. PLANKTONEMERTES VANHOEFFENI Brinkmann.

Bergens mus. aarbok, 1915, no. 1, p. 3, pl. **1**, fig. 1, 2, Figure 1; Bergens mus. skrift., 1917, ny raek., **3**, no. 1, p. 24; Deutsch. süd pol. exped., 1918, **16**. Zool., **8**, p. 282.

Figure 58–60.

This species is known from a single specimen which was very fully studied and described by Brinkmann ('15, '17, '18). This was a sexually mature female measuring after preservation 20.5 mm. in length, by 8.5 mm. in width, and 4.5 mm. in thickness. The worm in life was doubtless much flatter than these dimensions indicate, for the figures (Figures 58, 59) show that the dorsal musculature was violently contracted during preservation, throwing the atrium into a dorsal position and causing a corresponding thickening of the anterior portion of the body. The body is widest anteriorly and narrows gradually posteriorly. The body-musculature is very much reduced, but the basement-layer is of exceptional thickness.

Proboscis and proboscis-sheath. The proboscis is about twice as long as the body, and is armed with a sickle-shaped basis bearing a number of very small stylets (Figure 60). There are twenty-four proboscidial nerves. The proboscis-sheath is nearly as long as the body; its musculature consists of interlaced circular and longitudinal layers. The ring of insection is supported by radial bundles of muscles which are attached to the dorsal side of the cephalic walls.

Alimentary canal. The mouth and proboscis open together in a single atrium, as in the type species of the genus. This chamber is differentiated into two parts, the anterior of which is provided with a glandular epithelium resting on a basement-layer which is thrown up into slender branched processes of a shape not known for any other species. The posterior portion of the atrium resembles the rhynchodeum in appearance.

The oesophagus is rudimentary; but the stomach is quite voluminous, extending from the tip of the head to a point well back of the brain. The intestine is provided with numerous diverticula, each having a dorsal and a ventral lobe, each with smaller lobes. The intestinal caecum has five pairs of branched diverticula, the most anterior pair reaching forward in front of the brain.

Nervous system. The dorsal ganglia are smaller than the ventral. The lateral nerves each contain only a single fibrous case, and this is connected with the ventral ganglion. The dorsolateral nerves are large, originating from the junction of dorsal commissure and ganglia and extend at least half-way to the posterior end of the body. These nerves lie on the dorsolateral aspects of the body, along the inner border of the musculature and send anastomosing branches through the muscular layers to unite with the dorsal nerve, while other branches connect with the lateral nerve. Although the dorsal nerve extends forward in front of the dorsal commissure it is there of diminished size and ends without direct union with any part of the brain. It is connected with the rest of the nervous system only through the anastomosing branches of the dorsolateral and lateral nerves.

FIG. 58–60.— *Planktonemertes vanhoeffeni* Brinkmann. Fig. 58, dorsal view of type specimen after preservation. The single opening (atrium) for mouth and proboscis is distorted dorsally by contraction during fixation. The worm in life was doubtless much flatter than is here indicated. × 2½. Fig. 59, lateral view of same specimen. Fig. 60, stylet-basis. × 108. (After Brinkmann, 1918).

Reproductive organs. This specimen was a female from which the eggs had just been discharged. There were fourteen pairs of empty ovaries, the ducts from which opened ventrally.

Geographical distribution.— Known only from the Atlantic Ocean west of the Cape of Good Hope (Lat. 35° 39′ S., Long. 8° 16′ E.). Collected by the German South Polar expedition in a vertical haul from 3000 meters to the surface. The species is certainly pelagic, for the net was not lowered to the bottom of the sea.

MONONEMERTES, gen. nov.

Body rounded anteriorly, flattened toward posterior extremity, which is provided with a distinct caudal fin; widest in middle third, narrowed at both ends; mouth and proboscis-opening united; intestinal diverticula relatively few.

This genus is required provisionally for the species described superficially by Joubin ('06) as *Planktonemertes sargassicola* from a single specimen from the North Atlantic. The affinities of the genus can be determined only after a study of the internal anatomy. Externally the specimen had a close resemblance to *Probalaenanemertes wijnhoffi*, but the mouth of the latter is separate from the proboscis-opening.

6. MONONEMERTES SARGASSICOLA (Joubin).

Planktonemertes sargassicola JOUBIN, Bull. Mus. océan., 1906, no. 78, p. 13, fig. 9.

Figure 61.

A single specimen, 8 mm. in length and nearly half as wide (Figure 61), is placed in the genus Planktonemertes by Joubin, but it certainly does not belong to that genus, as is proved by the shape of the body and the presence of a distinct caudal fin. The body is rounded anteriorly and widest near the anterior third, tapering gradually posteriorly and flattening into a caudal fin which is fairly well demarcated from the body. The mouth and proboscis-openings are united. The intestinal diverticula are relatively few but appear to have numerous short branches.

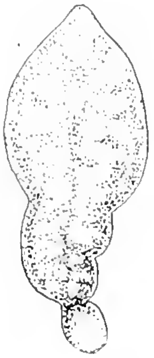

FIG. 61.—*Mononemertes sargassicola* (Joubin). (After Joubin, 1906).

The color in life was pale yellow in the anterior third of the body, with a median band of the same color extending the entire length of the body, bordered laterally in the middle of the body by yellowish orange with a brownish tinge.

Geographical distribution. The single known specimen was taken in the Sargasso Sea (Lat. 27° 36′ N., Long. 38° 29′ W.), in the bathypelagic net from 2225 meters to the surface.

The systematic position of this specimen must remain in doubt until a further study is made of its internal organization, but the combination of characters described by Joubin from a merely external examination indicates both specific and generic distinction from any of the other known pelagic nemerteans. In size and shape of body the species resembles *Probalaenanemertes wijnhoffi*, but the common opening for mouth and proboscis, if Joubin's observation is correct, indicate a different genus and one of doubtful affinities. If, on the other hand, the abnormal contraction of the body after the rupture and extrusion of the proboscis had caused an infolding of the tissues of the head so that mouth and proboscis falsely appeared to have a common opening, the status of the species would be entirely changed. It is thus not at all impossible that a study of the internal anatomy will show that this form is specifically identical with *P. wijnhoffi,* in which case it has priority.

CRASSONEMERTES Brinkmann.

Rept. Michael Sars, 1917, **3**, p. 6.

Mouth and proboscis-opening separate; proboscis-sheath extends almost the entire length of the body; body very broad and thick; caudal extremity distinctly demarcated from body; but without the development of a caudal fin; intestinal diverticula numerous, much branched; lateral nerve has but a single fibrous core.

7. CRASSONEMERTES ROBUSTA Brinkmann.

Rept. Michael Sars, 1917, **3**, p. 6; Bergens mus. skrift, 1917, ny raek., **3**, no. 1, p. 25, pl. 3, fig. 1–9.

Figure 62, 63.

Only one representative of this curiously broad and thick nemertean has been discovered. Its appearance in life is unknown. It was 25 mm. long, 10 mm. wide, and 4.5 mm. in thickness (Figure 62). The muscular walls of the body are so greatly reduced that only feeble movements of the body appear to be possible. It is suggested that the animal has little power of swimming, but is rather adapted for floating sluggishly at considerable depths.

Proboscis-sheath and proboscis. The proboscis-sheath extends to about 2 mm. from the posterior extremity of the body. Its musculature consists of interwoven circular and longitudinal fibers. The proboscis is large and about as long as the body. The retractor is interwoven with the musculature of the posterior end of the proboscis-sheath and thence passes through the dorsal wall of the sheath to become inserted in the longitudinal musculature of the body-wall (Figure 63). This provides a remarkably firm attachment to the body. There are twenty or twenty-one proboscidial nerves. The basis is bent almost at a right angle and bears at least ten small stylets.

Digestive system. An oesophagus is lacking, the terminal mouth leading directly into the stomach. There are about forty pairs of greatly branched intestinal diverticula, while the caecum bears at least five pairs of similar appendages.

Reproductive organs. The only known representative of this species is a female having about thirty-five pairs of ovaries. Each ovary had many immature ova.

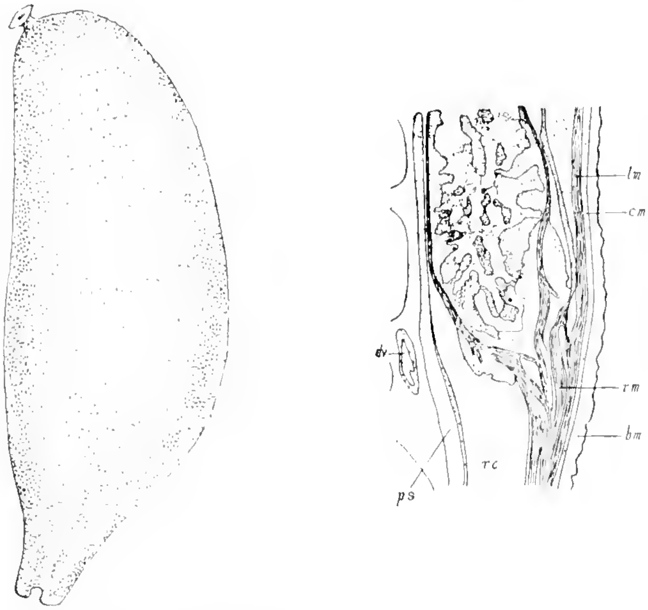

FIG. 62, 63.—*Crassonemertes robusta* Brinkmann. Fig. 62, type specimen, ventral surface. × 3. Fig. 63, portion of sagittal section near posterior end of body, showing the retractor muscles of proboscis (*rm*) passing through the dorsal wall of the proboscis-sheath to become inserted in the longitudinal musculature (*lm*) of the dorsal wall of the body; *bm*, basement-layer; *cm*, circular musculature of body-wall; *rc*, rhynchocoel; *dv*, dorsal vessel. × 33. (After Brinkmann, 1917a).

Geographical distribution. This specimen was taken in the North Atlantic (Lat. 57° 41′ N., Long. 11° 48′ W.) at a depth of about 1666 meters.

8. CRASSONEMERTES (?) RHOMBOIDALIS (Joubin).

Planktonemertes rhomboidalis JOUBIN, Bull. Mus. océan., 1906, no. 78, p. 14, fig. 11, 12.

Plate 3, fig. 26.

A single specimen from the Sargasso Sea superficially described by Joubin may represent a distinct species. This specimen was 11 mm. long after preservation and about two thirds as wide. The distinct caudal fin is bilobed posteriorly (Plate 3, fig. 26). Joubin states that the mouth and proboscis open together on a small anterior projection. Such a projection is found in Crassonemertes, but the mouth and proboscis-opening are actually slightly separated in the type species of that genus.

The color in life was translucent save for a wide band of marbled yellow-orange covering the median portions of the body for about two thirds its length; the band being limited laterally by the position of the nerve-cords, which are themselves, as is also the brain, bright red in color. There are "pyriform glands" at regular distances along the lateral borders of the body and others near the head. These are undoubtedly the ovaries.

Geographical distribution. This specimen was taken in the Sargasso Sea (Lat. 33° 51′ N., Long. 34° 03′ W.) in the bathypelagic net to 2000 meters.

The study of serial sections will be necessary to determine whether it is a distinct species and if so, whether it is correctly placed in the genus to which it is here assigned.

Mergonemertes Brinkmann.

Bergens mus. skrift., 1917, ny raek., **3**, no. 1, p. 28.

Mouth and proboscis-opening separate; proboscis-sheath limited to anterior half of body; body broad and much flattened. Only a single species has been described.

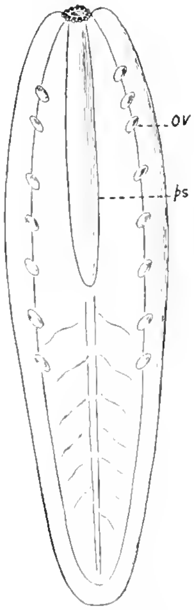

Fig. 64. — *Mergonemertes woodworthii* (Bürger). Outline of body, showing position of ovaries (*ov*) and extent of proboscis-sheath (*ps*). (After Bürger, 1909).

9. Mergonemertes woodworthii (Bürger).

Brinkmann, Bergens mus. skrift., 1917, ny raek., 1917, **3**, no. 1, p. 28.

Planktonemertes woodworthii Bürger, Wissens. ergebn. Valdivia, 1909, **17**, p. 202, pl. 10, fig. 4, pl. 11, fig. 1–6.

Figure 64.

The only known representative of this species measured 18 mm. long by 3.75 mm. in greatest width, and was about 2 mm. in thickness (Figure 64). The body was of a firmer consistency than in most other pelagic forms. The proboscis was not retained.

The longitudinal muscular layer of the body-walls is almost entirely lacking on the dorsal side of the anterior third of the body, but posterior to the proboscis-sheath it increases in thickness until it exceeds the same layer on the ventral side. This musculature is also extremely thin on the lateral margins throughout the length of the body.

The proboscis-sheath has a powerful wall of interlaced circular and longitudinal muscular fibers.

The intestinal caecum sends several diverticula anteriorly as far as the brain-region; two of these even reach in front of the brain. The intestinal diverticula are so closely crowded that they leave no space between them for the body-parenchyma, the latter, according to Bürger, being more completely suppressed than in any other nemertean.

The female is described as having about eight pairs of ovaries.

Geographical distribution. The single known specimen of this species, provisionally placed by Bürger in the genus Planktonemertes, was taken by the German Tiefsee expedition in Lat. 10° 8′ S. and Long. 97° 15′ E., a position on the eastern border of the Indian Ocean southwest of the island of Java. The specimen was taken in a vertical haul from 2400 meters.

NEURONEMERTES, gen. nov.

From the equatorial region off the west coast of South America the U.S.F.C. Steamer ALBATROSS secured a single specimen of a pelagic form which presents a combination of characters which requires the establishment of a new genus. The most remarkable anatomical features of the worms belonging to this genus are the presence of metameric problematical organs beneath the dorsal nerve, a remarkable specialization of the dorsoventral musculature in the region of the spermaries, and a high development of the subdorsal, cephalic, and peripheral nervous systems.

This new genus, for which the name Neuronemertes is proposed, evidently belongs to the Planktonemertidae, and may be distinguished from other genera by the following diagnosis:—

Body of moderate proportions; three to four times as long as broad; flattened; with thin lateral margins; rather sharply pointed anteriorly; somewhat narrowed posteriorly, with caudal fin. Mouth and proboscis open separately; proboscis-sheath about three fourths as long as body. Wall of proboscis-sheath mainly of interlaced fibers. Intestinal diverticula much branched; extending laterally both above and below the lateral nerves. Dorsal blood-vessel contained in rhynchocoel for a short distance back of brain. Subdorsal nerve paired and highly developed; cephalic nerves and all branches of the peripheral system well defined. Metameric problematical organs accompany the dorsal nerve. Dorsoventral muscles highly developed in the position of the spermaries. Spermaries in two rows immediately posterior to brain.

10. NEURONEMERTES AURANTIACA, sp. nov.

Plate **1**, fig. 2; Plate **4**, fig. 33; Plate **9**, fig. 61–65; Plate **10**, fig. 66–72; Plate **11**, fig. 73–79; Plate **12**, fig. 80–85; Plate **13**, fig. 89.

Figure 1, 27.

A single specimen of this hitherto undescribed species representing also a new genus was collected by the U. S. Fish Commission Steamer ALBATROSS during the Eastern Tropical Pacific expedition of 1904–1905. This specimen, after having been drawn in natural colors by Alexander Agassiz, was killed in picrosublimate, and later preserved in alcohol. This treatment resulted in an excellent fixation of most of the tissues of the body with the exception of the parenchyma. This gelatinous tissue, however, was in large measure destroyed, resulting in a most unusual shrinking and irregular infolding of the body-walls, much as if the specimen had been subjected to dessication. The space between body-walls and internal organs as shown in the drawings (Plate 9–12) is presumably less than one fourth as great as would be found in the living animal, for the preserved specimen had less than one fourth the total bulk of the animal in life, as shown by Mr. Agassiz's drawing.

Size and shape of body. The specimen measured after preservation 38.4 mm. in length and 7 mm. in width, with a thickness of about 2 mm., but the individual in life was 60 mm. long and 18 mm. wide. This difference in size illustrates both the enormous shrinkage of the tissues during preservation and the unreliability of proportional measurements of preserved specimens. The body is flattened, with thin lateral margins and is rather sharply pointed anteriorly; the posterior extremity is very thin and is terminated by a somewhat broadened caudal fin (Plate **1**, fig. 3; Plate **9**, fig. 61).

Color. The color in life is bright orange, of a somewhat deeper shade anteriorly and paler in the posterior portions, especially in the caudal fin (Plate **1**, fig. 2). The lateral nerves appear through the translucent tissues as fine red lines; the brain is also red in life. The body-tissues are much less hyaline, however, than in Pelagonemertes, corresponding with a smaller amount of gelatinous body-parenchyma.

Body-walls. The epithelium of the integument has been dislodged except in isolated patches, leaving the basement-layer with its surface corrugations freely exposed (Plate **10**, fig. 66, 67). The epithelium of the mouth and rhynchodeum, on the other hand, is beautifully preserved and shows the arrangement of the ciliated and glandular cells with remarkable distinctness. The surface of the basement-layer is thrown up into irregular longitudinal folds or corrugations, which are quite prominent on the anterior portion of the body, giving the body in this region a longitudinally striated or fluted appearance as seen under a magnification of ten diameters. Near the middle of the body the corrugations disappear except along the lateral margins (Plate **11**, figs. 73–79), where they continue nearly to the end of the body. The muscular layers appear to be better developed than in related forms, but this appearance is in part due to the excessive contraction due to the killing fluid used. The circular muscles are relatively thin, the great bulk of the body-walls consisting of a thick longitudinal layer, which is strongly developed even on the lateral borders of the body. In this specimen there is an unusual lengthwise folding of the walls, giving the body a very wavy outline in section (Plate **11**, fig. 79).

The dorsoventral fibers are remarkably large, and are present in great abundance between the intestinal diverticula along a line about midway between the proboscis-sheath and the lateral nerves on each side of the body (Plate **11**, fig. 79). In the lateral margins they are also well developed, particularly in the posterior half of the body (Plate **12**, fig. 84), while in the caudal fin they make up a large proportion of the body-tissues, in many places being separated from each other by hardly more than twice their diameter (Plate **12**, fig. 85). These muscles pass directly through the longitudinal muscular layer to become interlaced among the fibers of the external circular layer. A peculiar modification of the dorsoventral muscles occurs in the region of the spermaries. Here the strands of muscle are increased in size and number and closely invest the gonads (Plate **12**, fig. 80). The latter are not provided with the special spiral musculature that is found in Nectonemertes and to a lesser degree in Pelagonemertes. The apparatus necessary to provide for the forcible discharge of the mature sperm-cells is nevertheless present, for the dorsoventral muscles referred to are admirably adapted to accomplish this result.

The dorsoventral muscles are often accompanied by conspicuous nerve-fibers given off from the lateral nerves at intervals (Plate **11**, fig. 79). The muscular bands which connect the rhynchodeum at the proboscis-attachment to the dorsal and ventral cephalic walls are particularly massive in this species. This arrangement is much as described in this report for *Pelagonemertes brinkmanni*. As in the latter species, there are two main bands on the dorsal side and two on the ventral. These are attached peripherally to the cephalic walls on the corresponding sides of the head, by interlacing with the circular musculature, much as do the dorsoventral fibers farther back in the body. The four bands converge symmetrically to anchor the proboscis-attachment ring firmly in its place among the other cephalic tissues (Plate **10**, fig. 66, 67). Some of the fibers are also fastened to the posterior end of the short oesophagus and doubtless aid in the process of ingestion. In addition to the four main radial bands there are numerous separate radial muscular fibers which extend through the cephalic parenchyma from rhynchodeum to all parts of the cephalic walls (Plate **10**, fig. 66, 67).

Proboscis-sheath. The rhynchodeum opens subterminally, a short distance in front of the mouth. The proboscis-attachment, just in front of the brain, is reinforced, as stated above, by large strands of muscles which pass obliquely through the cephalic parenchyma to become inserted in the musculature of the cephalic walls on both the dorsal and ventral surfaces.

A very large nerve arises from the ventral ganglion on each side near the ventral commissure, passes forward and after dividing into several branches enters the wall of the rhynchodeum to supply the proboscis. The branches of the proboscidial nerves arrange themselves symmetrically in the inner wall of the rhynchodeum at the place of attachment of the proboscis, but because of the fact that the proboscis was torn from its attachment and lost at the time of collection the further course of the nerves cannot be followed. Their number appears to be approximately twenty.

The proboscis-sheath is provided with a musculature of unusual thickness. The muscles are not arranged in distinct layers, but the circular, longitudinal, and spiral fibers are interwoven in a most complex manner, much as in Drepanophorus, but with certain modifications noted below.

Plate **9**, fig. 62–65 show the relations of these interlacing muscular fibers in different regions of the sheath. In fig. 62, from a section taken a short distance back of the brain, the longitudinal muscles are scattered as isolated, individual fibers among the circular and spiral fibers. A little farther back (fig. 63) the circular fibers tend to group themselves toward the inner portion of the wall, while the longitudinal and spiral fibers are, for the most part, situated more distally. In the middle of the pyloric region (fig. 64) this tendency of the circular fibers to occupy the inner portion of the wall is more pronounced and the longitudinal fibers begin to arrange themselves in groups among them.

Still further back, toward the middle of the body (fig. 65), there is a fairly regular grouping of the longitudinal fibers into bundles of about a dozen or less, separated by an equal space occupied by circular and spiral fibers. The distal portion of the wall is still composed of isolated fibers intricately interlaced.

Here the longitudinal fibers predominate and they are here of much larger size than those which compose the longitudinal bundles in the inner portion of the sheath. The more distal spiral fibers are likewise larger than those nearer the rhynchocoel.

Throughout the length of the sheath the same relations continue, with a gradual increase in the spiral fibers toward the posterior extremity, and with very little decrease in the thickness of the walls. At a point about three fourths the distance toward the posterior end of the body the longitudinal fibers cease, and the spiral muscles terminate the sheath abruptly. There are no fibrous connections with the body-walls, the rounded end of the sheath lying free in the parenchyma. In the anterior portion of the body, where the dorsoventral muscles are so highly developed, certain strands of these muscles are closely applied to the lateral and dorsolateral aspects of the proboscis-sheath. From these strands branches appear to enter the sheath to become interwoven with the superficial spiral muscles of the latter. Such branches would serve to hold the sheath firmly in place and thus supplement the action of the proboscis supporting muscles which hold the proboscis-insertion ring in place.

Proboscis. This organ was missing in the single known example of the species, so that nothing is known regarding its structure and armature.

Alimentary canal. The mouth, which lies subventrally a little behind the rhynchodeal opening, is provided with numerous folds of glandular epithelium to allow great extension in the act of ingestion. The oesophagus is very short, with a continuation of the glandular epithelium. Immediately behind the brain the canal becomes more enlarged and its walls more convoluted to form a voluminous stomach.

Not far behind the brain the epithelial lining of the dorsal wall of the stomach becomes gradually differentiated and provided with a thinner and less glandular epithelium, while the ventral and lateral walls remain thick and convoluted. Gradually the thinner epithelium of the dorsal wall extends ventrally and the diameter of the canal decreases to form the pylorus. The epithelium of this portion of the canal consists of very regular columnar ciliated cells, with a few unicellular glands. The cilia are remarkably well preserved in this specimen.

At a point about one fourth the distance from head to posterior extremity of body the ventral wall of the pylorus opens into the dorsal wall of the underlying intestine, but the special character of the pyloric epithelium extends some distance farther back as a median band on the dorsal wall of the intestine.

The median intestinal canal extends anteriorly nearly to the brain as a broad caecum lying beneath the pylorus. It gives off several branches on each side. These extend laterally, dorsally, and anteriorly as lobed diverticula. The exact number could not be determined with certainty because of a defect in several of the sections, but there are about six pairs. Branches from these diverticula reach the lateral borders of the posterior portions of the brain. Both the diverticula of the caecum and those of the intestine proper are profusely branched, the branches extending ventrally as well as dorsally to the nerve-cords. They nearly surround the proboscis-sheath, the branches of the sides passing dorsally and then medially above the sheath nearly to the median line (Plate **4**, fig. 33).

Anteriorly the intestinal diverticula are closely crowded, but in the middle region of the body an increasing amount of parenchyma appears between them. The number was not definitely determined, but was probably about thirty. Near the caudal fin the diverticula become shorter and more widely separated. A narrow rectum, without diverticula, leads to the opening at the posterior extremity of the body (Plate **9**, fig. 61).

Each of the intestinal diverticula, as shown in Plate **12**, fig. 83, consists of two main lobes, one passing dorsal and the other ventral to the nerve-cord. The dorsal lobe is much the larger of the two and sends a narrow branch above the proboscis-sheath nearly to the median line, while the main branch reaches nearly to the lateral margin of the body, with numerous smaller lobules extending laterally and ventrally. Some of the lobes are distinctly forked distally in a horizontal plane. The ventral lobe (Plate **12**, fig. 83) is much smaller than the dorsal and reaches scarcely two thirds the distance from the median line to the lateral margin of the body. It is without distinct branches or deep lobules.

Blood-vessels. The vascular system has few deviations from that described for Nectonemertes and related genera. The median dorsal vessel lies in the rhynchocoel in the anterior one sixth of the body. After passing obliquely through the walls of the proboscis-sheath this vessel continues backward in the median line to form a broad union with the lateral vessels above the rectum just anterior to the dorsal commissure of the nerve-cords (Plate **9**, fig. 61). The blood-corpuscles are large and distinctly nucleated (Plate **10**, fig. 70). Their shape is oval or rounded and more or less discoidal.

Nervous system. The brain appears to be of unusually large size as compared with the body after preservation, but this is due in part to the method of preservation whereby the body-parenchyma has been shrunken to but a small fraction of its original dimensions by the extraction of the fluids of which it is so largely composed. The nervous tissues, being of a less fluid consistency, remain more nearly of their original proportions, and thus appear relatively larger than in life. The dorsal and ventral ganglia are closely fused and without a distinct line of demarcation (Plate 10, fig. 67). They merge gradually into the nerve-cords posteriorly.

In none of the other nemerteans described in this report are the nerves to the various organs of the body so large or so sharply differentiated. This is doubtless due in part to the action of the picrosublimate in which the worm was killed. Not only are the nervous elements much better preserved than in specimens killed in alcohol or formalin, but the course of the nerves among the other tissues can be followed more accurately. The dorsal nerve is remarkably well developed and is accompanied by a series of peculiar organs of a problematical nature, as described below.

Lateral nerves. Both dorsal and ventral brain-lobes merge posteriorly into the later nerve-cords. The fibrous core of the dorsal lobe extends into the lateral nerves as a small dorsal core, while the larger ventral core of the nerve-cords is a continuation of the fibrous core of the ventral brain-lobes, as in Nectonemertes and most other genera of pelagic nemerteans.

Dorsolateral nerves. A pair of conspicuous nerves, originating from the posterior borders of the dorsal ganglia (Figure 27), lies parallel with the dorsal nerve in the anterior portion of the body, the two members of the pair being situated symmetrically on the dorsolateral aspects of the body, above the lateral borders of the proboscis-sheath (Plate 10, fig. 68). They correspond to the subdorsal nerves described by Brinkmann ('17a) for Bürgeriella, Dinonemertes, and other forms, but as they are distinct from the subdorsal nerve of the Paleonemerteans the term dorsolateral should be applied to them in order to avoid confusion. These nerves send branches into the adjacent musculature to supplement the nerve-supply from the lateral cords, with which they are also connected by anastomosing fibers. They are likewise quite probably concerned in the control of the dorsoventral musculature so highly developed in this species in the immediate vicinity of the spermaries. From branches joining the dorsal nerve they presumably aid in the innervation of the proboscis-sheath.

Cephalic nerves. From the anterior and lateral borders of the brain numerous large nerves are supplied to the cephalic musculature and possible sense-organs.

Peripheral nerves. Three pairs of peripheral nerves leave the lateral cords at each of the spaces between the intestinal diverticula (Figure 27). One of these, the dorsal peripheral, arises from the dorsal side of the cord, the second from the ventral side, the ventral peripheral, and the third from the lateral aspect of the nerve-cord. After traversing the body-parenchyma dorsally, ventrally, and laterally, they are distributed to the respective parts of the body-walls. The lateral peripheral is usually much smaller than either of the other two. (Plate **13**, fig. 89; Figure 27).

Dorsal nerve. This nerve is large and conspicuous throughout the entire length of the body posterior to the brain-region. At the caudal extremity it passes directly into the posterior commissure of the lateral nerves, but near its anterior end it becomes more and more attenuated as it approaches the brain and appears to be only indirectly connected with the latter. Delicate communicating branches unite the dorsolateral nerve with the dorsal peripheral branches of the lateral nerve-cords, and there are similar communications with the dorsal nerve at intervals, bringing the entire nervous system into an integral unit (Figure 27).

Problematical organs. A further remarkable feature of this species is the presence of peculiar organs situated at regular intervals along the ventral side of the dorsal nerve throughout the length of the body (Plate **11**, fig. 73–78). The number of these problematical organs is upwards of one hundred, and presumably corresponds to a primitive segmentation. Those of the anterior portion of the body are somewhat less in diameter than the nerve-core itself, while posteriorly they are several times as large as the nerve, and are often in two or three lobes (Plate **11**, fig. 75, 78). It should be specially noted that the nerve-core lies outside the circular muscular layer while these organs are internal to this musculature and interposed between the bundles of the longitudinal muscular layer. The metameric connections between the nerve and these organs require the penetration of the circular muscles at regular intervals (Plate **11**, fig. 75–78). The openings in the circular muscles for these connections are sometimes very long and narrow as seen in transverse sections. This does not mean that the circular muscles are actually interrupted at these points, but rather that the bundles of circular fibers are separated in the median dorsal line so as to leave narrow transverse slits for the connections. A somewhat similar condition is described and figured by Brinkmann ('17a) for the dorsal nerve of *Bürgeriella notabilis.* In that species, however, there are broad anastomoses at intervals between the dorsal nerve and an intermuscular nerve-plexus lying between the circular and the longitudinal muscular layers. Both the dorsal nerve itself and the nerve-plexus are accompanied by small ganglion-cells, but there are no large groups of cells such as make up the problematical organs here described.

The organs referred to consist of closely placed cells with rather indistinct cell-boundaries and oval nuclei, and are directly connected with the dorsal nerve by means of the broad bands of nerve-fibers mentioned above. They extend through the entire thickness of the longitudinal musculature, making a continuous interruption of these muscles in the median line, for between the adjacent organs loose bundles of connective tissue extend between the body-parenchyma and the circular muscles beneath the dorsal nerve (Plate 11, fig. 78). The main core of this nerve is accompanied by only an occasional minute nucleus, and thereby differs from the corresponding nerve in Bürgeriella and most other nemerteans, where a few nerve-cells are always found along the lateral borders of the fibrous core.

The nature of these organs is quite obscure. It may be suggested that they are metameric ganglia and that the cells of which they are composed are actually nerve-cells. In support of this view it should be noted, first, that the cells of which they are composed do not differ greatly from ganglion-cells in size and general appearance, and, second, that no other nerve-cells are present in the neighbourhood. On the other hand, no such grouping of nerve-cells has been found in the nemerteans except in the brain, lateral nerves, and sense-organs. It seems, therefore, quite possible that these organs may be of a sensory nature, but the entire absence of pigment at the base of the organs would seem to preclude the possibility that they may function as ocelli. It may be suggested that they are light-producing organs, for their structure is quite similar to that of phosphorescent organs in some other animals, although nothing of this nature has been described among the nemerteans. Living, as these worms probably do, at a depth of perhaps 300 fathoms, the presence of light-producing organs might well prove an advantageous adaptation. Certainly they have been developed and retained in nearly all other groups of invertebrates, including the platyhelminths. For these reasons their occurrence in the bathypelagic nemerteans does not seem incredible, although the weight of evidence seems to indicate that the organs are modified ganglia.

Reproductive organs. The single specimen available for study was a male with ten pairs of spermaries situated immediately back of the brain and limited to the anterior fourth of the body (Plate 9, fig. 61). The gonads of each side are arranged in a single irregular row, with the most anterior ones so closely crowded together that they overlap in transverse sections of the body, while the more posterior ones are more widely separated. The situation of the gonads is ventral and sometimes slightly medial to the nerve-cords.

Each spermary opens to the ventral surface of the body by a rather slender, slightly curved or spiral duct. This sperm-duct is lined with cuboidal cells with distinct rounded nuclei (Plate **10**, fig. 71, 72). In some cases the duct is somewhat enlarged proximally to form a rudimentary seminal vesicle. It is quite possible that this chamber may become more highly developed when the spermatozoa are fully matured, as is the case in Nectonemertes and some related genera. It is suggested that the sperm-ducts may possibly serve as excretory organs, and that they are homologous with the nephridia of littoral species. If such be actually the case the genital products are discharged through the nephridia — a condition that has many parallels in other animals.

The spermary is not provided with the heavy spiral musculature described in this report for Nectonemertes and Pelagonemertes. There is, however, a highly developed mechanism to accomplish the same result, namely, the forcible discharge of the spermatozoa. This results from a modification of the dorsoventral musculature, as described above, whereby the dorsoventral fibers are greatly increased in size and closely invest the gonad (Plate **12**, fig. 80). Their contraction will not only decrease the dorsoventral axis of the body, but will actually compress the gonads.

It seems not unreasonable to assume, as in the case of other pelagic forms, a primitive type of sexual union, either with insemination of the female or coincident discharge of the gametes in both sexes.

The female is as yet unknown.

Geographical distribution. The only specimen of this species thus far known was taken in the Pacific Ocean off the coast of Ecuador, South America, a short distance south of the Galapagos Islands (Lat. 4° 1.6′ S., Long. 89° 16.3′ W.). The depth at this locality (Station 4645) is 2058 fathoms, but this specimen was brought up in the open trawl which was towed twenty minutes at 300 fathoms and then drawn vertically to surface. This shows that the worms are truly pelagic, but it does not prove whether they live at the surface or at the depth at which the net was towed. The probability is, however, that a depth of about 300 fathoms is their natural habitat, and this is in accord with more precise data on related forms, taken in self-closing nets at about this depth.

BÜRGERIELLIDAE Brinkmann.

Rept. Michael Sars, 1917, **3**, p. 6.

Body broad but rather thick; mouth and proboscis-opening separate; intestine narrow, with few widely separated diverticula, which are provided with extremely numerous, slender branches; proboscis-sheath consists of an inner layer of circular muscles and an outer layer of longitudinal fibers. Spermaries behind the brain.

BÜRGERIELLA Brinkmann.

Rept. Michael Sars, 1917, **3**, p. 7.

Body broad and fairly thick; mouth and proboscis-opening separate; proboscis-sheath nearly as long as the body; its wall consisting of separate muscular layers of which the circular is internal; intestinal diverticula few, but profusely branched into numerous slender processes.

The single species thus far described, *B. notabilis,* reaches a length of more than 50 mm. The profuse branching of the intestinal diverticula and the arrangement of the muscular layers of the proboscis-sheath separate it from all other known pelagic species.

11. BÜRGERIELLA NOTABILIS Brinkmann.

Rept. Michael Sars, 1917, **3**, p. 7; Bergens mus. skrift., 1917, ny raek., **3**, no. 1, p. 30, pl. 5, fig. 4–20, Figure 6.

Figure 65–68.

But a single specimen of this peculiar form with its profusely branched intestinal diverticula is known at present. The body is broad and moderately flat, with broadly rounded anterior border; widest a short distance behind the head and tapering gradually to the rather narrow, rounded posterior extremity. There is no caudal fin, the posterior end being less flattened than in most pelagic forms (Figure 65, 67).

Size. The single specimen measured, after preservation, 52 mm. in length and 15 mm. in greatest width, with a thickness from 2.5 to 4 mm.

Color. Unknown.

Body-walls. The basement-layer is thick and deeply pitted for the attachment of the surface-epithelium. Both of the circular and longitudinal musculatures of the body-walls are very thin, especially toward the lateral margins. Dorsoventral muscles are but little developed.

Alimentary canal. The mouth and proboscis-opening are separate; the former passes directly into the stomach. The intestinal diverticula are few in number, but are profusely branched. They are narrow and rather widely separated. Each diverticulum forks into a larger dorsal and a smaller ventral branch, and each of these divides repeatedly to form numerous slender, terminal branches (Figure 66–68).

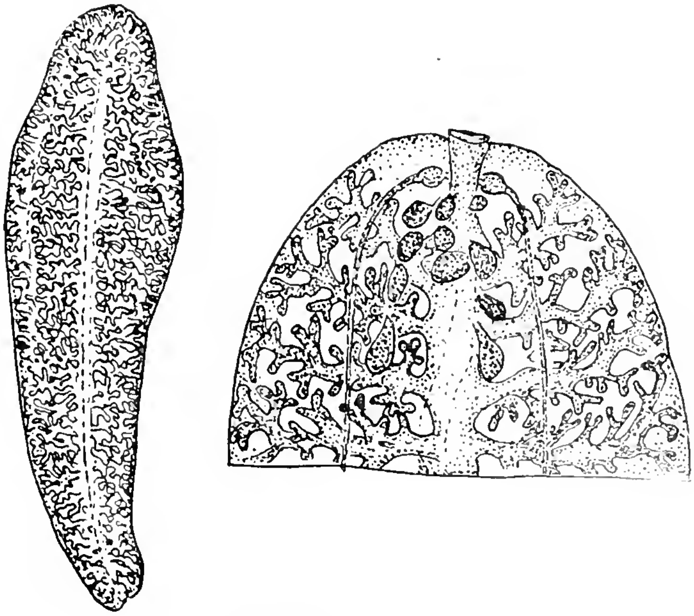

FIG. 65, 66.—*Buergeriella notabilis* Brinkmann. Fig. 65, type specimen from dorsal surface. × 1.5. Fig. 66, ventral view of anterior end of body cleared in oil, showing the position of brain, lateral nerves, spermaries, mouth, and digestive organs, with the dichotomously branching diverticula. In order to show the brain, the most anterior pair of intestinal diverticula is omitted. × 7. (After Brinkmann, 1917).

The slender intestinal caecum stretches forward anterior to the brain. It bears six pairs of much branched diverticula similar to those of the intestine and also a number of slender, unbranched, ventral lobes. The presence of two large shreds of chitin, apparently originating from copepods, suggests the nature of the food of this species.

Proboscis and proboscis-sheath. The proboscis is somewhat longer than the body and is peculiar in that the outer circular muscular layer is lacking in the middle region of the organ. There are twenty-one nerves, which form a nerve-ring near the armature. The latter consists of a long, arched basis bearing at least twenty-seven very small stylets. The proboscis-sheath extends nearly to the posterior end of the body.

Nervous system. The dorsal nerve is remarkably well developed. It terminates anteriorly a short distance behind the brain, with which it is in communication only through the transverse dorsal branches of the lateral nerves described below. These anastomoses pass directly through the circular muscular layer in a manner quite similar to that described in this report for *Neuronemertes aurantiaca.*

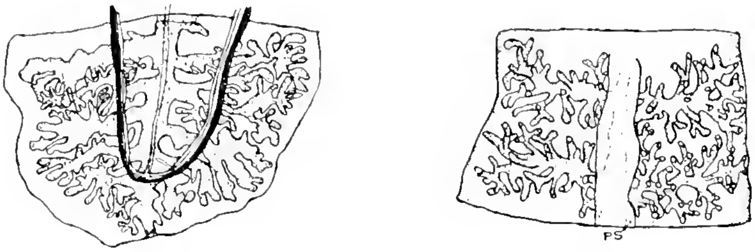

Fig. 67, 68.—*Buergerilla notabilis* Brinkmann. Fig. 67, outline of posterior end of body, showing the posterior unions of lateral nerves and the three longitudinal vessels, the profusely branched intestinal diverticula and the very short rectum. Fig. 68, dorsal view of two pairs of intestinal diverticula, showing the dendritic branching; *ps*, proboscis-sheath. (After Brinkmann, 1917a).

The lateral nerve-cords send out metameric transverse nerves which originate in groups of three:—ventral, lateral, and dorsal. These supply the musculature and other organs in the adjacent regions. The ventral transverse nerve originates from the ventral core of the lateral nerve-cord. It supplies the adjacent musculature and after passing peripherally through the longitudinal muscular layer forms a broad ventral anastomosis with the corresponding nerve of the other side of the body. The lateral branch supplies the lateral portions of the body-walls; while the third, dorsal, branch sends off fibers both to the dorsal body-walls and to the proboscis-sheath and then joins its mate from the opposite side of the body in a broad dorsal anastomosis which lies between the longitudinal and circular muscular layers. At intervals the circular muscular layer is interrupted in the median dorsal line to allow the passage of fibers connecting this intermuscular anastomosis with the dorsal nerve.

Reproductive organs. The single specimen known at present was a sexually mature male, with six spermaries irregularly situated on each side near the median ventral line and directly posterior to the brain (Figure 66). The spermary is provided with a single layer of circular muscles.

Geographical distribution. One specimen was collected by the Michael Sars expedition in the North Atlantic (Lat. 48°, 29′ N., Long. 13° 55′ W.) at a depth of about 1333 meters.

DINONEMERTIDAE Brinkmann.

Rept. Michael Sars, 1917, **3**, p. 7.

Body broad and very flat; mouth and proboscis-opening separate; caudal fin broad and very flat, but not sharply demarcated from the body; intestinal diverticula without distinct branches, and ventral branch rudimentary or wanting; spermaries in two rows back of brain.

Two genera have previously been assigned to this family, and two other genera are necessitated by new forms described in this report. These may be easily distinguished by the following key:—

A. Mouth posterior to ventral brain-commissures; proboscis-sheath reaches almost to posterior end of body; wall of sheath of interwoven fibers . . . . . . *Paradinonemertes.*
AA. Mouth anterior to brain; wall of proboscis-sheath with separate muscular layers . . . . . . B.
  B. Proboscis-sheath limited to anterior two thirds of body . . . . . . *Dinonemertes.*
  BB. Proboscis-sheath extends nearly the entire length of body . . . . . . C.
    C. Dorsal branches of intestinal diverticula distinctly forked and lobed; nerve-cord with separate dorsal and ventral fibrous cores . . . . . . *Planonemertes.*
    CC. Dorsal branches of intestinal diverticula usually without lobes; nerve-cord with but a single fibrous core . . . . . . *Plionemertes.*

PARADINONEMERTES Brinkmann.

Bergens mus. aarbok, 1915, no. 1, p. 4.

Body broad and much flattened; mouth situated posterior to brain; proboscis-sheath extends well into posterior third of body, its muscular wall being composed of interlaced fibers; brain close against ventral surface of head.

Of this genus only a single species, *P. drygalskii*, has been described. It differs from all other known pelagic forms in the position of the mouth.

12. PARADINONEMERTES DRYGALSKII Brinkmann.

Bergens mus. aarbok, 1915, no. 1, p. 4, pl. 1, fig. 3, 4, Figure 2, 3; Bergens mus. skrift., 1917, ny raek., **3**, no. 1, p. 35, pl. 7, fig. 16, 17, Figure 7, 8.

Figure 35, 69–71.

Although the general shape of the body in this genus is similar to that in Planktonemertes, the two genera are easily distinguished by the position of the mouth, which in Paradinonemertes opens on the ventral surface of the head posterior to the brain-commissures. The two specimens of this form known at present measured respectively 15 by 5.3 mm. and 11.5 by 4.5 mm., with a thickness of but 1 to 1.5 mm. The body terminates in a flattened caudal fin (Figure 69).

The proboscis-sheath is nearly as long as the body. The proboscis is armed with a slightly-curved basis bearing several rows of stylets (Figure 70, 71).

The mouth is described as leading directly into the short stomach, and the latter into an unusually long pylorus. The intestinal caecum is very long and bears six pairs of diverticula. The intestine has forty or fifty pairs of closely appressed diverticula which have occasional small lobes, but are not distinctly branched.

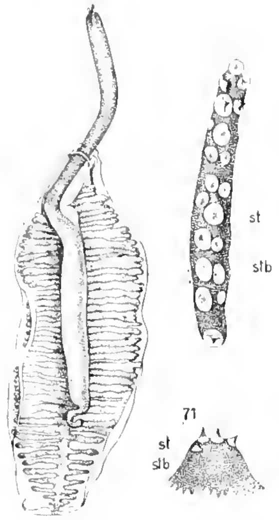

FIG. 69–71.—Paradinonemertes drygalskii Brinkmann. Fig. 69, dorsal view, showing extent of rhynchocoel. × 3. Fig. 70, stylet-basis (*stb*) and stylets (*st*). Fig. 71, transverse section of stylet-basis (*stb*) and stylets (*st*). × 633. (After Brinkmann, 1918).

The brain lies so close to the ventral surface of the head that the ventral commissure is in contact with the ventral cephalic wall. The lateral nerves, as in many other pelagic forms, receive fibers from both dorsal and ventral ganglia.

The two known specimens were both males, and each was provided with only two pairs of spermaries, situated immediately behind the brain and between the stomach and the lateral nerves (Figure 35). This is the smallest number of gonads as yet known in any nemertean.

Geographical distribution. Known only from the Atlantic Ocean west of the Cape Verde Islands (Lat. 17° 28′ N., Long. 29° 42′ W.); the two specimens having been taken in a vertical haul from 3000 meters to the surface.

DINONEMERTES Laidlaw.

Ann. mag. nat. hist., 1906, ser. 7, **17**, p. 186.

Body very large, broad and flat, but yet fairly thick. Mouth and proboscis-opening separate; proboscis-sheath limited to anterior two thirds of body, its muscular wall of separate layers; intestinal diverticula not distinctly branched.

Three species have been described, in one of which (*D. investigatoris*) the worms may reach a length of over 200 mm., with a width of over 50 mm., and a thickness of 15 mm., and are to be considered the giants among the pelagic nemerteans. A fourth species (*D. mollis*) is described in this report. The three species in which the internal anatomy has been studied may be distinguished as follows:—

A. With about 36 to 40 pairs of intestinal diverticula . . . . *D. mollis.*
AA. With about 50 or more pairs of intestinal diverticula . . . . B.
B. With three pairs of caecal diverticula; proboscis with 30 or more nerves *D. investigatoris.*
BB. With two pairs of caecal diverticula; proboscis with 28 nerves . . . . *D. alberti.*

The species rather superficially described by Joubin ('06) under the name *Planktonemertes grimaldii*, evidently also belongs to this genus. The single known specimen although sexually mature was but 40 mm. long and one fourth as wide.

13. DINONEMERTES INVESTIGATORIS Laidlaw.

Ann. mag. nat. hist., 1906, ser. 7, **17**, p. 186, pl. 8, fig. 1; Murray & Hjort, Depth of the ocean, 1912, p. 578, fig. 414; Brinkmann, Rept. Michael Sars, 1917, **3**, p. 8; Bergens mus. skrift., 1917, ny raek., **3**, no. 1, p. 37, pl. 3, fig. 11, pl. 6, fig. 1–20, pl. 7, fig. 1–3, Figure 9–11.

Figure 1, 16, 72–74.

The worms belonging to this species are the giants among the pelagic nemerteans and, indeed, they are exceeded in size by only a few littoral species.

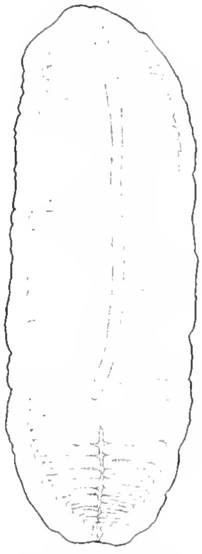

FIG. 72.— *Dinonemertes investigatoris* Laidlaw. Preserved specimen; half natural size. (After Laidlaw, 1906).

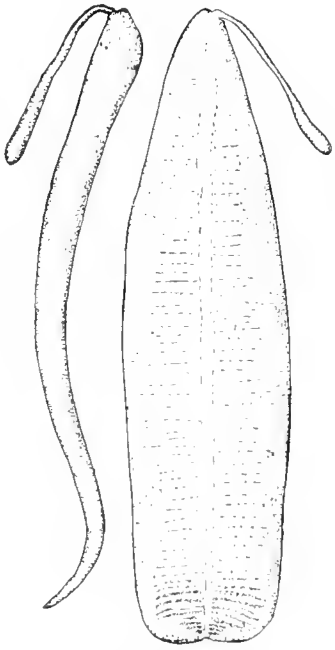

FIG. 73.— *Dinonemertes investigatoris* Laidlaw. Lateral and dorsal views of a large specimen; half natural size. (After Brinkmann, 1917).

The body is very broad and flat, becoming extremely thin toward the posterior end (Figure 72, 73). The species was superficially described by Laidlaw from a single specimen measuring 150 mm. long, 48 mm. wide and only 4 mm. in thickness. But even these dimensions are exceeded by one of the two specimens studied by Brinkmann, which was 203 mm. long, 56 mm. wide and 15 mm. in greatest thickness. Brinkmann's second specimen was 107 mm. long, 23 mm. wide and 7 mm. thick.

Color. The animal is said to have been transparent in life, with a bright red or orange digestive system. The ova have a chrome-yellow tinge.

Proboscis and proboscis-sheath. The terminally placed proboscis-opening leads into a short rhynchodeum. The proboscis measures almost twice the length of the body itself, but the proboscis-sheath does not reach the posterior third of the body. There are thirty or more proboscidial nerves. The main portion of the basis is comparatively straight, but the end is sharply curved or hook-shaped. It bears more than twenty-five conical stylets, and there are several pouches of reserve stylets adjacent. The proboscis-retractor is attached to the posterior end of the rhynchocoel.

Digestive system. The intestine bears upwards of sixty to seventy pairs of diverticula which are closely placed and flattened into narrow vertical pouches (Figure 16, 74). They bear small lobules but are without distinct branches.

FIG. 74.— *Dinonemertes investigatoris* Laidlaw. Reconstruction of transverse section, showing the intestine opening into a pair of diverticula, the latter with short lobes above the proboscis-sheath; *ov*, ovary; *ln*, lateral nerve. (After Brinkmann, 1917a).

The caecum has three pairs of diverticula, of which the most anterior pair comes from its anterior end.

Vascular system. The three longitudinal vessels, with the two usual connections anteriorly and the dorsal union above the rectum are all well developed. The lateral vessels take a peculiar convoluted course, forming loops between, or even above, the intestinal diverticula and around the ovaries, instead of following closely the straight course of the lateral nerves.

Reproductive organs. The three known specimens were all females, Laidlaw having been in error in describing the type specimen as a male. In each specimen there were forty-two to fifty pairs of ovaries between the intestinal diverticula. Each ovary produces from six to eight very large eggs. These are filled with yolk and may reach a diameter of 2.5 mm., a size much greater than in any other known pelagic form.

Geographical distribution. The type specimen came from the Indian Ocean east of the Laccadives (Lat. 12° 2′ N., Long. 73° 46′ E.); depth about 2000 meters. The two other examples were taken in the North Atlantic (Lat. 48° 2′ N., 39° 55′ W., and Lat. 34° 44′ N., 47° 52′ W.) by means of a plankton-net lowered to about 2000 meters.

This great geographical divergence leads to the suspicion that in spite of the close similarity of the females examined, two distinct species may actually be involved, and that when males from both regions are discovered they may possibly reveal valid specific differences.

14. DINONEMERTES ALBERTI (Joubin).

Planktonemertes alberti JOUBIN, Bull. Mus. océan., 1906, no. 78, p. 9, fig. 6, 7.
Dinonemertes alberti BRINKMANN, Bergens mus. skrift., 1917, ny raek., **3**, no. 1, p. 47, pl. 7, fig. 4–15, Figure 12–13.

Figure 31, 38, 75.

This species also belongs among the giants of the pelagic nemerteans, being exceeded only by *D. investigatoris* in size. The body is very broad and flat, but is of considerable thickness except along the lateral margins and at the posterior end (Figure 75). The type specimen measured 85 mm. in length by 27 mm. in width, while the dimensions of the three specimens studied by Brinkmann were 66.5 by 19 mm., 70 by 21 mm., and 76 by 22 mm. The thickness was only from 5 to 10 mm., and near the posterior end of the body only 2 mm.

Color. The few notes regarding the color indicates that the living animals are reddish, reddish brown, or flesh-color.

Proboscis and proboscis-sheath. The rhynchocoel extends from one half to two thirds the length of the body, but the proboscis measures about twice the body-length, and has twenty-eight nerves. The stylet-basis is large, with at least twenty stylets.

Digestive system. Mouth and proboscis-opening are well separated. The intestine has about fifty pairs of unbranched diverticula, while the short caecum has but two pairs, of which the anterior pair originates from its anterior end.

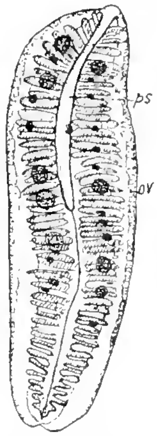

FIG. 75.— *Dinonemertes alberti* (Joubin). Dorsal view of specimen cleared in oil and dorsal surface removed, showing the short rhynchocoel (*rc*), intestine (*mi*), and ovaries (*ei*); *sn*, lateral nerve. × ca. 1.7. (After Brinkmann, 1917a).

Nervous system. The dorsal nerve is well developed and, as in most other pelagic forms, ends anteriorly without direct contact with the brain. Each of the pair of subdorsal nerves was found by

Brinkmann to leave the brain in two parts, one from the dorsal and the other from the lateral surface of the dorsal ganglion on each side. Both branches lie in the parenchyma beside the proboscis-sheath. They frequently anastomose with each other and with the lateral nerves. They supply the dorsolateral body-walls with many fibers and perhaps connect with the dorsal nerve, but the nerves of the two sides are not directly connected. Beneath the intestine is a network of anastomosing branches from the lateral nerves (Figure 31).

Reproductive organs. The female has from eighteen to twenty-five pairs of ovaries, in each of which but a single very large ovum is usually produced (Figure 75).

The male, as figured, by Joubin, has a row of six or more closely placed spermaries on each side immediately back of the brain (Figure 38).

Geographical distribution. This species has been found only in the Arctic Ocean between Iceland and Norway (Lat. 63° 12′ N., Long. 1° 30′ E.; Lat. 67° 29′ N., Long. 11° 32′ W.; Lat. 69° 02′ N., Long. 7° 29′ W.; Lat. 71° 18′ N., Long. 9° 20′ W.), between depths of from 1310 to 3320 meters and the surface. There is every reason to believe that the species is bathypelagic.

15. Dinonemertes grimaldii (Joubin).

Planktonemertes grimaldii Joubin, Bull. Mus. océan., 1906, no. 78, p. 4, fig. 1–5.
Dinonemertes grimaldii Brinkmann, Bergens mus. skrift., 1917, ny raek., **3**, no. 1, p. 53.

Plate **3**, fig. 27, 28.

The two known representatives of this species, superficially described by Joubin, were each about 40 mm. long and 10 mm. wide, the body being rather broad, with parallel lateral margins, but rounded at both ends (Plate **3**, fig. 27, 28). The color of the body in life was orange-red.

The mouth and rhynchodeum open separately but near together. The intestinal canal bears numerous diverticula, which become gradually smaller posteriorly. Joubin's diagram indicates that they are not branched. The proboscis is large, pale red in color, and about as long as the body. The armature was not discovered. The musculature of the body-walls is extremely reduced; it is difficult to find on the lateral margins of the body, but in the dorsal and ventral walls the longitudinal bundles are better developed.

There are two rows of genital pores on the ventral surface, with fourteen or fifteen small papillae in each row. The sex is not stated, but since the genital pores appear from the brief description to extend well back in the body, both specimens may be assumed to have been females.

Pending further information regarding the armature of the proboscis, the length of proboscis-sheath, the character of intestinal diverticula, and other anatomical features, the systematic position of the species must remain somewhat doubtful.

Geographical distribution. Two individuals of this species were collected by the PRINCESS ALICE expedition (1905) in the North Atlantic. One of these was taken in the Sargasso Sea (Lat. 31° 41′ N., Long. 42° 40′ W.) and the other off the Azores (Lat. 37° 33′ N., Long. 22° 39′ W.). Both were caught in the bathypelagic net from 3000 meters to surface.

16. DINONEMERTES MOLLIS, sp. nov.

Plate **13**, fig. 86, 87.

A single specimen belonging to this genus was taken by the ALBATROSS off the west coast of Mexico.

This specimen was about 24 mm. in length by 6 mm. in width, with a thickness of a little more than 1 mm. after long preservation in alcohol.

The body is broad and very flat, with nearly parallel margins which may be more or less undulating according to the state of contraction. The anterior extremity is rounded; the posterior end somewhat narrower, but provided with a flattened caudal fin directly continuous with the lateral margins of the body (Plate **13**, fig. 86, 87).

The epithelium is entirely dislodged in this specimen, leaving the basement-layer exposed. In surface view this basement-layer is found to be divided into irregular polygonal areas by anastomosing ridges of considerable height. In sections of the body these ridges are seen to consist of narrow projections of the exposed basement-layer.

Proboscis-sheath and proboscis. The proboscis-sheath is about two thirds as long as the body, while the proboscis is much coiled in its natural position (Plate **13**, fig. 87) and is of a length much greater than that of the entire body. The preservation was such that the character of the armature of the proboscis could not be determined.

Digestive system. The mouth is situated on the anterior margin of the body, immediately ventral to the opening of the rhynchodeum. The rudimentary oesophagus, stomach, pylorus, and caecum reveal no striking differences from other species of the genus described so fully by Brinkmann ('17a).

There are upwards of forty pairs of intestinal diverticula in this specimen.

These are lobed irregularly but are without distinct branches. The ventral branch is rudimentary or absent.

Nervous system. The brain is of moderate proportions and presents no marked deviations from that of related species. The lateral nerves contain but a single fibrous core continuous with that of the ventral ganglia. The dorsal commissure above the rectum is near the posterior end of the body as in other species.

Reproductive organs. This specimen is a female with about thirty pairs of rather immature ovaries (Plate 13, fig. 87). Each gonad contained from four to six ova, in addition to the numerous small follicle-cells. It is reasonable to suppose that, as in related forms, one or two of these ova will eventually absorb all the others, thus bringing to maturity but one, or perhaps two, ova in each gonad.

It may be noted that there are nearly twice as many pairs of ovaries in this form as in the somewhat larger *D. grimaldii*, as indicated by the fourteen or fifteen pairs of oviducts figured by Joubin for the latter species. Also *D. alberti*, which is very much larger than *D. mollis* has but eighteen to twenty-five pairs of ovaries.

Geographical distribution. The single known specimens of this species was taken by the ALBATROSS October 14, 1904, at Station 4595. This point lies off the southwest coast of Mexico (Lat. 17° 7′ N., Long. 101° 35′ W.) The depth in this region is about 1000 m. but the specimen was obtained in a vertical haul from about 600 m. to the surface with two small plankton-nets set tandem about 4 m. apart.

The specimen described indicates that members of this species are somewhat smaller than those of any of the three other species hitherto described, for specimens of *Dinonemertes investigatoris* are the largest pelagic nemerteans known, measuring up to 203 mm. in length. Specimens of *D. alberti* are recorded having a length up to 85 mm., while the two known specimens of *D. grimaldii* were about 40 mm. long. The figures given above for *D. mollis* were taken after preservation in alcohol for many years and should be considerably increased in estimating the proportions of the living animal, giving a size not greatly less than that of *D. grimaldii*.

PLANONEMERTES, gen. nov.

The ALBATROSS collections contained one well-preserved specimen similar in size and shape to *Planktonemertes agassizii* and like the latter having the proboscis-sheath extending almost the entire length of the body. This specimen differed, however, in having the mouth and proboscis-opening separate and in having much less branched intestinal diverticula. Serial sections showed that the proboscis-sheath consists of three, more or less separate, muscular layers and that the nerve-cord is provided with both dorsal and ventral fibrous cores. These and the other anatomical features showed that the specimen belongs to the Dinonemertidae but that it could not be included in either of the established genera of that family. For the new genus thus necessitated, the name Planonemertes is proposed. This genus differs from Paradinonemertes in having the mouth on the anterior margin of the body instead of behind the brain, as is the case in the latter genus, and also in having separate muscular layers in the proboscis-sheath. From Dinonemertes this new genus is easily distinguished by the much greater extent of the proboscis-sheath, and by the more highly developed lobes of the intestinal diverticula.

The genus Planonemertes may therefore be diagnosed as follows:— body flat and broad, with parallel margins, terminating posteriorly in a broad caudal fin not distinctly demarcated from the body; proboscis-sheath extends nearly the entire length of the body, of three separate muscular layers, of which the inner is circular and is thicker than the longitudinal and the outer combined; intestinal diverticula numerous, with the ventral branch rudimentary and the dorsal branch lobed or forked dorsally and distally, but not distinctly branched; nerve-cord with separate dorsal and ventral fibrous cores; spermaries in two narrow groups or irregularly double rows back of the brain.

The only species at present known is *Planonemertes lobata*.

17. PLANONEMERTES LOBATA, sp. nov.

Plate **3**, fig. 20; Plate **13**, fig. 88; Plate **14**, fig. 92–97.

Figure 26, 34, 41, 76, 77.

The single representative of this species thus far known was a mature male taken by the ALBATROSS in the equatorial Pacific. This specimen measured after preservation in alcohol about 25 mm. in length, 7 mm. in width and 1 to 1.5 mm. in thickness.

The body is elongated oval, with parallel lateral margins, about three and one half times as long as broad and much flattened throughout. The anterior extremity is evenly rounded, the proboscis-opening being located on the anterior margin, with the mouth immediately ventral to it. The posterior end is also smoothly rounded with margins flattened to form a broad caudal fin, but without demarcation from the body (Plate **13**, fig. 88; Figure 76).

Body-walls. Sections show that the body-walls are provided with a rather thick longitudinal musculature bordered externally by a thin circular layer, the former averaging about five times as thick as the latter (Plate **14**, fig. 92, 96, 97).

In the head and anterior portions of the body the musculature of the body-walls is much thinner than in the middle and posterior regions of the body. As in so many pelagic forms there are two very thick plates of longitudinal muscles on the dorsal side of the body and two similar plates on the ventral side. They reach their greatest thickness about a third of the way from the median line to the lateral margin, being thinner near the median axis of the body and tapering to a very thin band laterally (Plate **14**, fig. 96, 97). In the second third of the body these muscles reach a thickness nearly four times as great as in the region of the gonads. This massive development is correlated with the presence of a broad caudal fin and a flattened body adapted for undulatory movements in floating and swimming.

The individual muscular fibers of the body, not only those of the body-walls but also those of the dorsoventral bundles and particularly those of the proboscis-sheath, are much larger than in most other nemerteans. The fibers along the inner portions of the walls tend to be larger than those more distally situated.

The dorsoventral musculature is well developed, with a series of regularly paired bundles alternating with the intestinal diverticula. A pair of particularly large muscular bands extends between the dorsal and ventral surface close beside the proboscis-sheath at each interdiverticular space. The two ends of each of these bands pass through the longitudinal muscles to become interlaced with the circular layer above the proboscis-sheath and beneath the intestine. The interlacing above the sheath frequently appears as a conspicuous loop continuous with the dorsoventral bundles. As these bands pass close

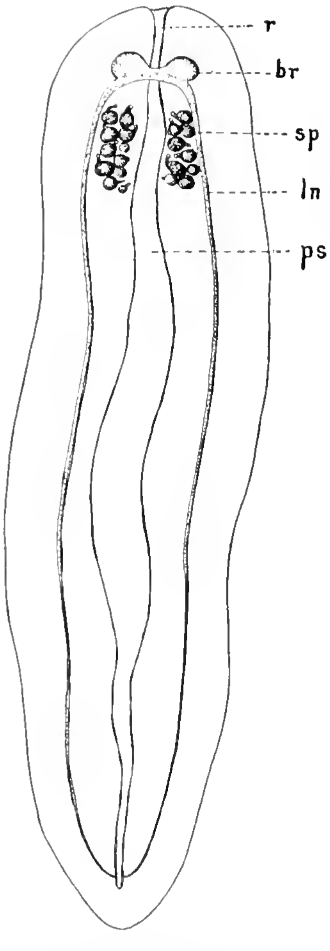

Fig. 76.— *Planonemertes lobata* Coe. Outline of body of mature male with nine spermaries (*sp*) opening on the ventral surface on one side of the body immediately back of the brain and eleven on the other side; *r*, rhynchodeum; *br*, brain; *ln*, lateral nerve; *ps*, proboscis-sheath. × 5.

beside the proboscis-sheath a few interlacing fibers from the latter may join them to give the sheath a firm anchorage to the dorsal wall of the body. But this does not occur at all of the interdiverticular spaces, for many of these bands may be traced directly from dorsal to ventral surface without contributing to the proboscis-sheath (Plate **14**, fig. 96).

The fibers of the dorsoventral muscles are usually much more wavy or deeply spiral than any of the other muscles of the body except those of the contracted proboscis-sheath.

Horizontal sections of the body show that in general there are two series of these muscular bands in each interdiverticular space, one series passing close beside the anterior and the other beside the posterior border of each of the intestinal diverticula.

Proboscis-sheath and proboscis. The proboscis-sheath extends almost the entire length of the body, ending freely in the parenchyma above the short rectum (Plate **13**, fig. 88). The proboscis was not present in the single specimen thus far known, although it was so securely fastened to the wall of the sheath that the rupture which occurred when the proboscis was forcibly ejected left a small portion of its posterior end still attached to the sheath. This is not a peculiarity of the present species, however, for similar fragments are frequently left in Nectonemertes and other pelagic forms.

The method of attachment consists of an intricate weaving together of the longitudinal retractor-muscles of the proboscis with similar fibers of the sheath. To accomplish this the retractor-muscles must pass between the thick band of inner circular fibers of the sheath, with which they are also interwoven to some extent. In fact, a considerable number of fibers from the thin outer layer of circular or spiral muscles of the sheath are directly connected with the proboscis-musculature. This makes so firm an anchorage that in the spasmodic contraction of the body, the walls of the proboscis itself are ruptured, leaving the posterior tip of the proboscis in its natural position. The fragment which remains shows the usual arrangement of muscles and glandular epithelium.

The proboscis-sheath throughout its length is composed of three rather distinctly demarcated muscular layers, although there is more or less interweaving of the fibers. The inner layer is much the thickest and is composed mainly of circular muscles; external to this is a longitudinal layer less than half as thick, while the most external layer is relatively thin and consists of circular and spiral fibers (Plate **14**, fig. 95).

Alimentary canal. The mouth opens on the anterior margin of the head immediately ventral to the proboscis-opening. It leads through a rudimentary oesophagus to the stomach, the latter with much folded and richly glandular walls. The narrow pylorus lies immediately beneath the proboscis-sheath as in other forms and opens into the dorsal wall of the intestine at a point about 2.5 mm. back of the brain or about 4 mm. from the tip of the head. This would be about one sixth the distance from the anterior to the posterior end of the body.

Intestinal caecum. The intestinal caecum is thus formed and extends forward nearly to the brain, having an actual length of about 2.3 mm. From the caecum several pairs of diverticula extend laterally above the nerve-cords. The most anterior pair of these is broadened distally, and is irregularly lobed but without distinct branches. This pair extends anteriorly nearly to the posterior border of the brain. The other caecal diverticula are more distinctly lobed laterally, with a short dorsal lobe beside the rhynchodeum, but a ventral branch is entirely lacking.

Intestinal diverticula. There are between forty and fifty pairs of diverticula, all of which are more or less regularly lobed but only a few of them are distinctly branched (Plate **13**, fig. 88). They are not closely appressed in this form, but are separated by a considerable amount of parenchyma (Plate **14**, fig. 94). Frequently the space between two diverticula is almost equal to the antero-posterior thickness of the diverticulum itself. The ventral branch, so well developed in Planktonemertes, is represented merely as a small, rounded lobe which in no case extends laterally as far as the nerve-cord (Plate **14**, fig. 97). The main diverticulum is homologous with the dorsal branch in Planktonemertes. This sends a small lobe dorsally beside the proboscis-sheath, while the main branch extends laterally above the nerve-cord to the lateral margin of the body. This branch is frequently broadened distally and divided into two or more lobes in a horizontal plane (Plate **14**, fig. 94). Great irregularities are found in these terminal lobes. The distal enlargement and lobing of the more highly developed diverticula results in such an encroachment on the adjacent inter-diverticular spaces that a more slender, almost rudimentary diverticulum is frequently found in the space between two of the larger diverticula. For a short distance there may be a more or less regular alternation of larger and smaller diverticula, while elsewhere all may be similar in size (Figure 77).

In the posterior half of the body the diverticula are more slender and with smaller and fewer lobes. The space between the ends of the diverticula and the lateral margins of the body gradually increases toward the posterior end of the body, leaving a wide caudal fin into which the diverticula do not penetrate.

Just anterior to the anastomosis of the nerve-cords there are two pairs of rudimentary diverticula represented only by rounded intestinal lobes, and posterior to them the narrow rectum leads to the anus at the posterior margin of the body (Plate **13**, fig. 88). In the main intestinal canal, and especially in the diverticula, the lumen is very small and is usually entirely obliterated by the closing together of the walls of the constituent epithelium. The cells are very large, with irregular amoeboid projections and are in great part filled with vacuoles. The nuclei are large and spherical. Interspersed among these vacuolated cells are occasional glandular cells filled with a deeply staining granular secretion quite similar to those found in the pylorus. Such cells are very conspicuous in sections.

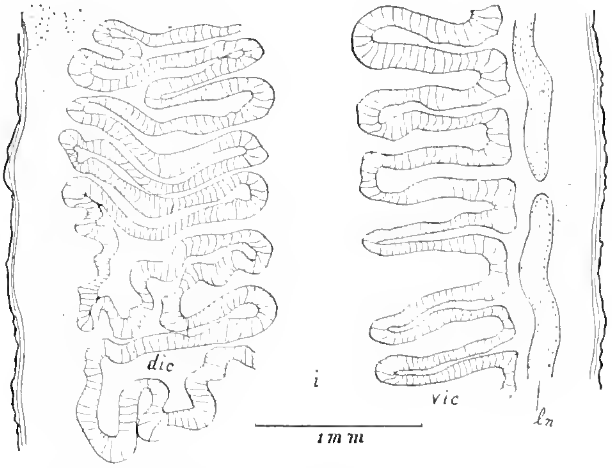

Fig. 77.— *Planonemertes lobata* Coe. Small portion of longitudinal section of the intestinal diverticula; *i*, intestine; *dic*, dorsal, and *vic*, ventral diverticula respectively; *ln*, lateral nerve.

Numerous separate bundles of dorsoventral muscles pass close beside the diverticula along both their anterior and posterior borders.

Blood vascular system. The usual relations exist between the lateral and the cephalic vessels, with dorsal anastomosis above the rhynchodeum. The dorsal vessel, however, presents a deviation from the usual type in that it arises from the fusion of two vessels which originate from the ventral anastomosis and pass posteriorly for some distance beneath the ventral wall of the proboscis-sheath (Figure 26). It is in the region of the most anterior pair of spermaries, about 3 mm. back of the tip of the head, that these two vessels fuse together to form the median dorsal vessel, which immediately passes obliquely through the muscular wall of the sheath to enter the rhynchodeum. After extending a distance of only 1.5 mm., within the rhynchocoel the vessel enlarges into a bulb-like sac, from the posterior ventral wall of which the vessel extends obliquely backward through the ventral wall of the sheath. The point at which the vessel leaves the sheath is thus about a 0.4 mm. posterior to the opening of the pylorus into the intestine, or about midway between the most anterior and posterior spermaries. The vessel is not at once free from the sheath, however, for a thin strand of circular or oblique muscles binds it to the sheath for some little distance further back. Eventually it lies free in the parenchyma between the intestine and the sheath and thus extends to its union with the lateral vessels at the posterior end of the body.

Nervous system. The brain and its commissures are of moderate proportions, with the usual nerves leading to the cephalic organs. The dorsal and ventral ganglia are closely fused, with a single fibrous core having a dorsal and a ventral lobe. The lateral nerves contain both dorsal and ventral fibrous cores, connected with the corresponding brain-lobes. The dorsal core is about a third of the diameter of the ventral and separated from it by a thin layer of nerve-cells, while similar nerve-cells border the ventral side of the ventral core. Although the ventral branches of the intestinal diverticula are absent, yet the nerve-cords are situated deep in the body-parenchyma and widely separated from the ventral wall of the body (Plate **14**, fig. 92, 96, 97). They lie a little more than half-way from the median line to the lateral margin of the body.

The posterior commissure of the nerve-cords above the rectum is as in most other pelagic forms. The median dorsal nerve is remarkably small, but the metameric branches from the lateral cords are unusually large and are frequently accompanied by small ganglion-cells.

As a rule four pairs of peripheral nerves leave the lateral cords in each inter-diverticular space. These are (*1*) the large dorsal peripheral nerves, (*2*) the dorsolateral, (*3*) the lateral and (*4*) the ventral peripheral nerves, much as described for *Neuronemertes aurantiaca* and illustrated on Plate **13**, fig. 89.

The dorsal peripheral nerve extends dorsally through the parenchyma, passing beside the proboscis-sheath, sending branches both to the musculature of the sheath and to that of the dorsal body-wall, eventually communicating with the dorsal nerve through the fine intermuscular plexus which lies between the circular and longitudinal muscular layers of the body-wall. This nerve originates from the dorsal fibrous core of the nerve-cord.

The dorsolateral peripheral nerve leaves the lateral border of the ventral core and passes dorsally and laterally to supply the dorsolateral portion of the body-walls.

The lateral peripheral nerve originates just ventral to the dorsolateral or in conjunction with it by a single nerve which branches just outside the neurilemma. Frequently both nerves run side by side for some distance, with one or more anastomosing branches between them. Eventually this nerve supplies the ventrolateral body-wall. The ventral peripheral nerve leaves the ventral side of the cord or, sometimes, the ventromedial side. This is a large nerve with branches to the musculature on the ventral side of the body and it has one or more anastomoses with the corresponding nerve of the opposite side.

Although these four nerves frequently appear to be quite independent of each other, yet anastomosing branches are so commonly found as to suggest that all are united into a general nervous plexus within the parenchyma as well as indirectly by means of the delicate intermuscular plexus which lies between the two muscular layers of the body-walls throughout the circumference of the body.

Nerve-cord muscles are not present.

Reproductive organs. The only known specimen of this species is a mature male with nearly ripe gametes. The gonads lie in two elongated groups or double rows on the ventral side of the body a short distance posterior to the brain. In this specimen there are nine of these spermaries on one side of the body and eleven on the other. They are so closely placed that when fully mature the walls of adjacent gonads are in contact (Plate **13**, fig. 88). Each gonad is nearly globular in form, with a short spermatic duct opening directly to the ventral surface of the body (Plate **14**, fig. 92).

Serial sections show that there is a thin muscular wall surrounding the germinal epithelium. The fibers of this musculature run nearly horizontally but in a slightly spiral course from the neck of the gonad toward its distal end. A few delicate muscular fibers continue into the wall of the spermatic duct. Here they take a longitudinal position, as described by Coe and Ball ('20) for Nectonemertes. A delicate connective tissue sheath surrounds the entire gonad and duct.

The contents of the gonad consist of crowded germinal cells, with spermatids in various stages of metamorphosis into the mature spermatozoa. As already described by Coe and Ball ('20) for a similar stage of development in Nectonemertes and as Brinkmann ('17a) has so well shown for that and other species, the most peripheral of the germinal cells are mainly spermatogonia, while the primary and secondary spermatocytes and the spermatids lie in compact groups, the cytophores, nearer the center of the gonad (Figure 41). In no case are the cell-boundaries clearly demarcated, although the nuclei are sharp and distinct.

The spermatogonia are easily distinguished by the coarse chromatin reticulum of their nuclei. The primary spermatocytes are considerably larger than the spermatogonia, have a less granular cytoplasm, and are arranged in small groups, each of which presumably has arisen from the repeated division of a single spermatogonium. No cell-outlines are present, the cytoplasm of all the cells of a group fusing to form a continuous protoplasmic mass, or cytophore. The nuclei, however, are sharply defined and the chromatin shows plainly that it is arranged in slender threads. Stages of synizesis and synapsis are undoubtedly present, as are also a few division figures.

The division of the primary spermatocytes leads to compact groups of smaller secondary spermatocytes, and the common cytoplasmic mass of the cytophore becomes more sharply defined (Plate **14**, fig. 93, 93a).

The nuclei of the spermatids resulting from the division of the secondary spermatocytes now become arranged in a single layer along the periphery of the cytophore. With the elongation of their nuclei the young spermatids assume a radial position in the cytophore, with their pointed anterior ends near the center of the cytoplasmic mass. With the gradual elongation of the nucleus to become the slender head of the spermatozoan a small part of the peripheral cytoplasm becomes differentiated into the middle-piece and tail. The young spermatozoa eventually lose their radial position and the cytophore breaks up into smaller groups or bundles of parallel spermatozoa (Plate **14**, fig. 93a).

The lining of the spermatic duct consists of a single layer of cuboidal cells which become flatter at the proximal end of the duct where they join the spermatogonia (Figure 41).

Geographical distribution. The single specimen of this species thus far collected was taken by the ALBATROSS in the equatorial Pacific at Station 2792 (Lat. 0° 37′ S.; Long. 81° 0′ W.) in an open net drawn at about 600 meters, While there is no direct proof as to the depth at which the species lives we may feel justified in assuming from the structure of the body that the animal floats or swims sluggishly by dorsoventral contractions of the body at a considerable depth, and the chances are that the specimen was secured from the depth at which the net was drawn.

PLIONEMERTES, gen. nov.

A single specimen taken off the coast of Peru resembled *Planktonemertes agassizii* in size and in the general shape of the body. Serial sections showed that the new form differs decidedly in the shape of the intestinal diverticula, in the arrangement of the layers of the proboscis-sheath and in the armature of the proboscis. The combination of anatomical features requires the establishment of a new genus, Plionemertes, diagnosed as follows: —

Body very broad and flat; elliptical in outline; posterior extremity much flattened, but without demarcated caudal fin; proboscis-sheath extends entire length of body; wall of proboscis-sheath of three distinct muscular layers, of which the inner and outer are circular; intestinal diverticula numerous, irregularly lobed but not distinctly branched, ventral lobe not reaching lateral nerve; lateral nerve with but a single fibrous core.

18. PLIONEMERTES PLANA, sp. nov.

Plate **15**, fig. 98–102.

Figure 19, 20, 78.

The single specimen was cleared in oil for superficial study and then cut into serial sections, the anterior end of the body being cut transversely and the rest horizontally.

Shape and size. The body is elliptical in outline, and is very flat, with thin, parallel lateral margins (Plate **15**, fig. 98, 99). At the posterior end of the body the lateral margins are prolonged into a broad caudal fin. The specimen after long preservation measured about 15 mm. in length by 5 mm. in width, with a thickness of 1 mm. or less. The intestinal diverticula are opaque, but the thin lateral margins are translucent.

Musculature. In none of the other species described in this report is there such a highly specialized body-musculature, the dorsal and ventral sides of the body having unusually thick plates of longitudinal muscles, while a broad area on the lateral margins is almost devoid of this muscular layer (Figure 19, 20). The circular musculature is everywhere thin, while the dorsoventral muscles are compensatingly well developed.

Parenchyma. Sections of the body show that there is a very large amount of parenchyma separating the intestinal diverticula and other organs of the body (Figure 19, 20).

Proboscis-sheath. The proboscis-sheath extends the entire length of the body, the proboscis being attached in its extreme posterior end. The musculature of this organ is arranged in three more or less distinct layers, of which the inner is circular, the middle longitudinal, and the outer circular or spiral. Of these the inner circular is the most highly developed, being about equal in thickness to the other two layers combined. The outer, spiral, layer is about half as thick as the longitudinal layer. At certain points along the length of the sheath the regularity of these layers is interrupted and more or less interlacing of the fibers between the inner and outer layer occurs. But in both transverse and longitudinal sections there is little difficulty in distinguishing the three layers (Figure 19, 20).

The anterior end of the body had been injured and the body-musculature had contracted more than that of the proboscis-sheath, so that the latter projected anteriorly for some distance through a rupture in the cephalic walls. The pylorus retained its connection with the sheath and likewise extended beyond the other cephalic tissues.

Proboscis. The proboscis was fully everted and of a surprising length. Although its retractor was still inserted in the posterior end of the sheath, the proboscis was everted from the anterior end of the body for a distance of about 25 mm., or more than one and one half times the body-length. And since the total length of the everted organ is double its measured length and since its posterior end still extends the entire length of the rhynchocoel its total length must be more than four times the body-length (Plate 15, fig. 98, 99).

The anterior chamber shows the usual groups of rhabditic papillae and the typical muscular layers.

The number of proboscidial nerves is forty-seven or forty-eight, of which twenty-four are larger than the others and may be considered the primary nerves. Alternating more or less regularly with the latter are twenty-three or twenty-four secondary nerves, most of which are considerably smaller than the primary. In some portions only nineteen of these secondary nerves can be distinguished, making a total of only forty-three in all. The others have become incorporated into the nerve-plexus connecting the nerves.

The lumen of the stylet-chamber is directly continuous with that of the posterior end of the anterior chamber, but the walls of these two portions of the proboscis are differentiated as in other pelagic forms. The stylet-basis is large and is more or less crescentic in transverse sections. A reconstruction of the serial sections shows that the basis is shaped like a flattened hook or spoon, the proximal portion being cylindrical, the middle portions flattened and trough-like, and the distal part spoon-shaped (Plate 15, fig. 100, 101).

The posterior chamber is very long and slender, with the usual thin muscular walls and glandular lining.

The contraction of the body after preservation was such that the posterior end of the proboscis-sheath was distended and the proboscis-retractor much contracted and imbedded in the posterior end of the sheath by interlacing muscular fibers (Figure 78). As indicated in the figure the retractor is formed by a direct continuation of the longitudinal muscles of the proboscis, which form a broad band of fibers. This band then breaks up into many smaller bundles, the fibers of which pass directly into the adjacent wall of the proboscis-sheath to become interlaced with the muscular fibers of the latter. The outer epithelium at the posterior end of the proboscis is transformed into a thick layer of closely crowded and overlapping columnar cells (Figure 78), in marked contrast with the thin layer of flattened cells which elsewhere cover the proboscis. Undoubtedly this effect is partly due to the strongly contracted condition of the retractor in this specimen.

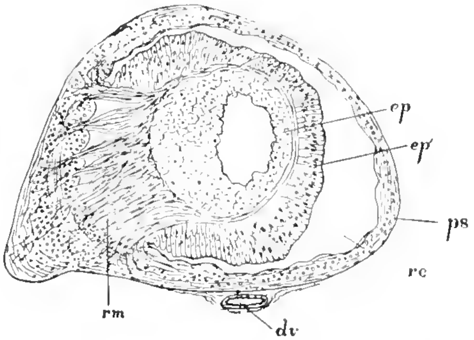

FIG. 78.—*Pliomemertes plana* Coe. Posterior end of proboscis, with the retractor-muscles (*rm*) interlaced among the muscles of the proboscis-sheath (*ps*); *ep*, inner epithelium of proboscis; *ep'*, thickened outer epithelium of proboscis, bathed in the fluid of the rhynchocoel (*rc*); *dv*, dorsal vessel.

Digestive system. The anterior end of the body had been injured during capture, so that it is impossible to make any definite statements regarding the stomach, pylorus, and caecal diverticula. As shown by a cleared preparation of the entire body (Plate 15, fig. 98, 99) there are about thirty-two pairs of intestinal diverticula, in addition to several small and irregular lobes at the posterior end of the intestine. Each of these diverticula is provided with a large dorsal lobe and a much smaller ventral lobe. Both are without lateral branches. The dorsal lobe, however, is often provided with several broad irregular, widely opened pouches, of which one extends dorsally beside the proboscis-sheath and another passes laterally nearly to the lateral margin of the body. The ventral lobe separates from the dorsal lobe near the origin of the latter from the central intestinal canal and extends laterally something less than half-way from the median line to the lateral margin of the body. In no case does the ventral lobe reach the nerve-cord, however. Both lobes in this specimen have large open lumens (Figure 19, 20).

Vascular system. The dorsal blood-vessel extends the entire length of the body, to join the lateral vessels in the usual anastomosis above the rectum. As in other related genera it passes into the rhynchocoel for a short distance near its anterior end.

Nervous system. The lateral nerves lie about midway between the median line and the lateral margins of the body (Plate 15, fig. 98; Figure 19, 20) with the usual commissure above the rectum. There is but a single fibrous core with a thick layer of nerve-cells on both dorsal and ventral sides.

Reproductive organs. The only known specimen of this new species was a female with about twenty pairs of rather small and immature ovaries situated in the parenchyma on the dorsolateral borders of the lateral nerves (Plate 15, fig. 102). The ovaries alternate regularly with the intestinal diverticula. Each consists of a thin-walled sac of fibrous tissue lined with a thin layer of protoplasm forming a continuous syncytium (Plate 15, fig. 102). Two types of nuclei are easily recognized: those that are nearly circular in outline, of larger size and with a conspicuous nucleolus, are in the primitive ova, while the smaller oval nuclei belong to the nutritive cells of follicular protoplasm. The larger ova project freely into the lumen of the ovary and have in their peripheral protoplasm several oval nutritive nuclei. At the lower end of the ovary the small nuclei are closely placed and represent the beginning of the oviduct. The position of the developing oviduct is just lateral to the nerve-cord, but it is in this early stage far removed from the ventral body-wall, through which it would eventually open if growth continued (Figure 20).

In spite of the fact that very numerous young ova begin the elaboration of yolk-material it is highly probable that in this species as in other pelagic forms, only one or at most two of these will develop into mature ova, while all the others will become abortive and will finally be absorbed by the common syncytium.

Geographical distribution. One specimen was taken by the ALBATROSS Eastern Tropical Pacific expedition, 18 November, 1904, at Station 4666 (Lat. 10° 55′ S., Long. 84° 20′ W.), a position off the west coast of Peru. The depth at that locality is about 5200 meters, but the label states that the specimen came up in a wing of the trawl "probably from less than 300 fathoms." Presumably that is an inference drawn from the fact that similar nemerteans had been taken in nets lowered to that depth, but there is really no evidence as to the depth at which the species lives, for the trawl was drawn from the bottom of the ocean. The bottom-temperature was 34.9° F. and the surface-temperature 69° F.

PHALLONEMERTIDAE Brinkmann.

Rept. Michael Sars, 1917, **3**, p. 14.

Body slender, flattened ventrally; caudal fin present; intestinal diverticula somewhat lobed, but without trace of ventral branch; proboscis-sheath about three fifths the length of body; spermaries in two rows behind the brain; sperm-ducts prolonged into slender tubular papillae.

There is but one genus, Phallonemertes, belonging to this family. The mature males are easily distinguished from all other pelagic forms by the character of the sperm-ducts.

PHALLONEMERTES Brinkmann.

Rept. Michael Sars, 1917, **3**, p. 14.

Bathynectes BRINKMANN, Bergens mus. aarbok, 1912, no. 9, p. 1.

Body slender, with parallel sides; flattened on ventral surface; caudal fin well developed; mouth and proboscis-opening separate; spermaries with cylindrical external genital papillae, projecting in a single row on ventral surface of each side of anterior end of body.

19. PHALLONEMERTES MURRAYI Brinkmann.

Rept. Michael Sars, 1917, **3**, p. 14; Bergens mus. skrift., 1917, ny raek., **3**, no. 1, p. 55, pl. 8, fig. 1–20, pl. 9, fig. 1–20, Figure 14–15.

Bathynectes murrayi BRINKMANN, Bergens mus. aarbok, 1912, no. 9, p. 1, pl. 1, fig. 1–5.

Figure 36, 37, 79, 80.

This remarkable pelagic nemertean, the males of which have slender external genital papillae, was described from twenty-one specimens. The body is moderately slender, with nearly parallel lateral margins. The anterior end of the body is rounded, while the posterior extremity bears a broad, bilobed caudal fin (Figure 79). The sexually mature males were from 34–46 mm. long and 5-8 mm. wide, while the mature females measured 35–61 mm. in length and 7 to 10 mm. in width.

Proboscis and proboscis-sheath. The proboscis-opening is separate from the mouth; the proboscis-sheath extends through about three fifths the length of the body but the proboscis somewhat exceeds the body in length. The armature of the proboscis consists of a small crescentic basis bearing numerous extremely small stylets and a varying number of pouches of accessory stylets. There are fifteen to seventeen proboscidial nerves.

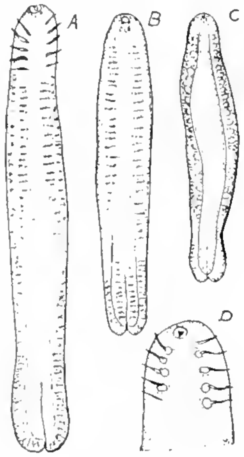

FIG. 79.—*Phallonemertes murrayi* Brinkmann. A. Mature male from ventral surface, showing genital papillae (penes). × 1.2. B. Female with immature ovaries, from ventral surface. × 1.2. C. Female with mature ovaries. nat. size. D. Anterior end of male, showing genital papillae. × 2.5 (After Brinkmann, 1917a).

Digestive system. The mouth leads almost directly into the stomach; the latter is short, but the pylorus is unusually long. The intestinal caecum has five pairs of large, branched diverticula which meet dorsally above the proboscis-sheath. The first pair of these originates from the very end of the caecum. The intestine itself has forty to fifty pairs of similar appendages.

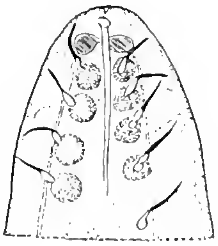

FIG. 80.—*Phallonemertes murrayi.* Brinkmann. Ventral surface of anterior end of male, showing the slender genital papillae leading from the spermaries through the seminal vesicles. × 4. (After Brinkmann, 1917a).

Body-walls. As in many pelagic forms, the longitudinal muscular layer of the body-walls is well developed on the dorsal and ventral surfaces, but almost lacking along the lateral margins of the body posteriorly. The circular layer is very weak throughout the body.

Vascular system. The dorsal blood-vessel is well developed, and joins in the posterior union of the lateral vessels immediately anterior to the union of the lateral nerves.

Nervous system. The proboscis-nerves originate as a single pair of large trunks from the anterior dorsal border of the dorsal ganglia and divide into separate nerves at the ring of insertion of the proboscis. The dorsal nerve is well developed, but comes to an end anteriorly without direct union with the brain or its commissures. The dorsolateral nerves are unusually conspicuous throughout the length of the body.

Reproductive organs. From twenty-four to twenty-nine ovaries, each with at most four eggs when fully matured, are situated on each side in the interdivertioular spaces (Figure 79). The oviducts lead to the ventral surface near the lateral nerves, but the opening is not formed until the eggs are ready to be discharged.

The males have four to seven spermaries in a single row on each side of the body immediately posterior to the brain (Figure 36, 80). The wall of the spermary consists of a sheet of connective tissue enclosing a thick muscular layer of circular or spiral fibers, more or less interwoven, as in Nectonemertes and Pelagonemertes (Figure 37). The muscular layer does not reach the body-wall, but is replaced by a layer of cuboidal epithelium enclosing a small chamber, the seminal vesicle, which leads into the genital papillae (Figure 37).

The genital papillae extend far beyond the body-walls as slender, cylindrical penes (Figure 37, 80). Brinkmann suggests that these organs may actually be inserted into the oviducts of the female at the time of insemination, for a primitive type of pairing is to be assumed for these and some of the other bathypelagic nemerteans. In certain of the specimens the genital papillae had been torn from the body-tissues, and this may be accounted for if it be supposed that the papilla is filled with spermatozoa by the contraction of the musculature of the spermary, and after being inserted into the oviduct of the female is then ruptured and left in connection with the oviduct when the two worms separate. The genital papilla would thus serve as a spermatophore. This supposition, as Brinkmann states, requires for confirmation the actual presence of such organs clinging to the female. Nevertheless the facts recorded furnish strong support for the theory that copulation, perhaps with internal fertilization, may occur in this and other species of pelagic nemerteans.

Geographical distribution. The species is rather widely distributed in the North Atlantic Ocean, being recorded from eight different localities, ranging from the Mid-Atlantic (Lat. 34° 44′ N., Long. 47° 52′ W.; Lat. 48° 2′ N., Long. 39° 55′ W.; Lat. 48° 24′ N., Long. 36° 53′ W.; Lat. 48° 4′ N., Long. 32° 25′ W.) to near the southern point of Greenland (Lat. 59° 12′ N., Long. 51° 5′ W.) and near the west coast of Ireland (Lat. 48° 29′ N., Long. 13° 55′ W.).

The methods of the Michael Sars expedition, which secured most of the specimens, where a number of nets are simultaneously drawn horizontally, each at a certain depth, shows that this species is stenotherm and stenohaline, inhabiting only a water-layer with a temperature of between 3° and 4° C. and a salinity of from 34.9% to 35%. These conditions are encountered at a depth of about 1600 to 2000 meters in the regions of the North Atlantic where the species was taken. At the several stations of the Michael Sars expedition where this species was taken no specimens were secured in the nets drawn at a depth of 1666 meters or less, while in the nets at 2000 meters seventeen specimens were caught. This indicates a habitat with a rather sharply demarcated upper limit for this species.

Chuniellidae Brinkmann.

Rept. Michael Sars, 1917, **3**, p. 14.

Body moderately broad and flat, narrowed posteriorly; caudal fin not demarcated from body; proboscis-sheath of separate muscular layers, of which the inner is longitudinal; intestinal diverticula without ventral branch; spermaries in two rows or elongated groups posterior to the brain.

Chuniella Brinkmann.

Rept. Michael Sars, 1917, **3**, p. 15.

Body of medium size and proportions: not much flattened; narrowed posteriorly to a pointed extremity; mouth and proboscis-opening separate; intestinal diverticula numerous, with small lobes, but without ventral branch; lateral nerves situated immediately internal to ventral wall of body; spermaries numerous, in an irregular longitudinal row along lateral nerve on each side immediately back of brain. The type species is *C. lanceolata*.

Brinkmann includes in this genus both Bürger's *Drepanophorus pelagicus* and his *Planktonemertes agassizii*. It should be noted, however, that the type species of Chuniella has the proboscis-sheath nearly as long as the body, whereas *D. pelagicus* has this organ only two thirds as long as the body and in *P. agassizii* it is only three fourths the body-length. If the length of the proboscis-sheath is to be looked upon as an important generic character, these three species should be placed in at least two separate genera. However, it can hardly be of service to formulate new generic definitions for species so little known as are two of these. The writer will therefore follow Brinkmann in assigning provisionally to the genus Chuniella both of Bürger's species to which reference is made.

A fourth species, superficially described by Joubin ('06) as *Planktonemertes elongata*, has such external features as would indicate that it also should be referred provisionally to this genus. Only the study of serial sections will determine whether the assignment is correctly made. So little is at present known of its internal anatomy that it cannot be included in the following key, which will distinguish the three other species.

A Proboscis-sheath extends nearly the entire length of the body; proboscidial nerves 21 *C. lanceolata.*
AA. Proboscis-sheath not more than three fourths as long as body .... B.
B. Colorless and translucent; proboscis-sheath about three fourths as long as body. *C. agassizii.*
BB. Body milk-white, head reddish; proboscis-sheath about two thirds as long as body; proboscidial nerves 21 .... *C. pelagica.*

20. Chuniella lanceolata Brinkmann.

Rept. Michael Sars, 1917, **3**, p. 15; Bergens mus. skrift., 1917, ny raek., **3**, no. 1, p. 67, pl. 2, fig. 10–16.

Figure 81.

But a single representative of this species has thus far been recorded. This was 10 mm. in length and 2.25 mm. wide, with a thickness of 1.2 mm. The body is flattened only in the middle third of its length, but rounded in transverse section both in front and behind, and it bears no trace of a caudal fin (Figure 81).

Proboscis and proboscis-sheath. The proboscis-sheath is almost as long as the body, and the coiled proboscis measures about double this length. The muscular layers of the sheath are not interwoven, nor does this musculature come in contact with the dorsal body-wall posteriorly. The proboscis is provided with twenty-one nerves and an armature of typical form.

Digestive system. The intestine has about thirty pairs of large, lobed but unbranched, diverticula, and the caecum has five pairs of similar appendages.

Reproductive organs. The single known specimen was a young male with twelve spermaries in an irregular row on one side close beside the lateral nerve just back of the brain and nineteen on the other side (Figure 81).

Geographical distribution. This specimen was taken in the North Atlantic (Lat. 48° 29′ N., Long. 13° 55′ W.), at a depth of about 1000 meters.

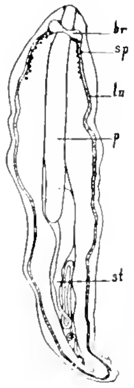

Fig. 81.— *Chuniella lanceolata* Brinkmann. Outline of type specimen, showing position of brain (*br*), lateral nerves (*ln*), proboscis (*p*), with stylet-chamber (*st*), and the elongated cluster, or irregular row, of spermaries (*sp*) on each side of the body immediately behind the brain. × 5. (After Brinkmann, 1917a).

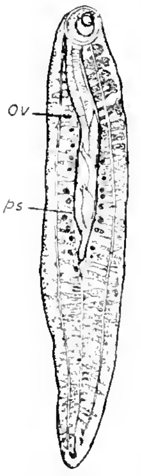

Fig. 82.— *Chuniella agassizii* (Bürger). Female with small ovaries (*ov*); *ps*, proboscis-sheath. (After Bürger, 1909).

21. Chuniella agassizii (Bürger).

Brinkmann Bergens mus. skrift., 1917, ny raek., **3**, no. 1, p. 71.

Planktonemertes agassizii Bürger, Wissens. ergebn. Valdivia, 1909, **17**, p. 200.

Figure 82.

Bürger (1909) erroneously identifies a small nemertean collected by the German Tiefsee expedition as *P. agassizii* Woodworth. This specimen was an immature female, only 9 mm. long and 2 mm. wide. The body is slender, broader anteriorly, more pointed posteriorly and flattened, but without distinct caudal fin (Figure 82).

Bürger mentions the following peculiarities, among others, of the internal organization.

Body walls. The circular muscular layer of body-walls is very thin; but the longitudinal layer is mainly in two broad sheets, one on the dorsal and the other on the ventral side of the body. Of these the ventral is two or three times thicker than the dorsal. The body-parenchyma is much reduced, the space within the body-walls being mainly filled with the crowded intestinal diverticula.

Digestive system. Mouth and proboscis-opening separate. An oesophagus is wanting, but the stomach extends posterior to the brain. The pylorus is remarkably long, giving a corresponding length to the intestinal caecum. The later sends out diverticula which almost completely fill the anterior portion of the head. The intestinal diverticula are numerous (50), only a minute terminal portion of the intestine being devoid of these appendages.

The proboscis-armature was not found.

Numerous young ovaries in this specimen alternate with the intestinal diverticula in the middle region of this body.

Geographical distribution. The single specimen known was taken in the vertical net from 1300 meters in the Atlantic Ocean west of Sierra Leone (Lat. 8° 58′ N., Long. 16° 27.9′ W.).

22. CHUNIELLA PELAGICA (Bürger).

Brinkmann, Bergens mus. skrift., 1917, ny raek., **3**, no. 1, p. 69.

Drepanophorus pelagicus BÜRGER, Wissens. ergebn. Valdivia, 1909, **17**, p. 179.

Figure 83.

But a single specimen of this species is known. This was of moderate proportions or rather slender, but little flattened, and gradually narrowed toward the posterior extremity. The caudal fin is but little developed (Figure 83). The length of the body after preservation was 25 mm. and the width 3 mm. The color in life is reported to have been milky white except that the head was of a reddish tint.

Body-walls. The basement-layer is thick, with abundant superficial corrugations. The circular muscular layer of body-walls is everywhere thin; the longitudinal layer consists mainly of two broad sheets, one dorsal and the other ventral, with only a few fibers along the lateral borders of the body, as in many other pelagic species. The posterior end of the body is much flattened, with an abundance of dorsoventral fibers.

Digestive system. The mouth and proboscis-opening are separate. The former opens almost directly into the stomach and this passes into the pylorus in front of the brain. The intestinal caecum extends forward to the brain. The intestinal diverticula are large and closely appressed.

Proboscis and proboscis-sheath. The proboscis-sheath reaches only to the beginning of the posterior third of the body, but the proboscis equals the body in length. Only three stylets were present on the sickle-shaped basis, but the positions of others were indicated. There are twenty-four proboscidial nerves.

Reproductive organs. The single known specimen was a female with an interrupted row of small ovaries on each side of the body. Each of these gonads produces but one or two large, yolk-bearing ova, nourished by an abundance of nurse-cells. The oviducts were formed as far as the basement-layer just lateral to the lateral nerves.

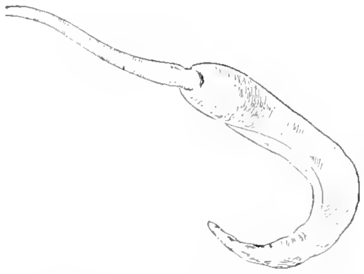

FIG. 83.—*Chuniella pelagica* (Bürger). Outline of body with everted proboscis. (After Bürger, 1909).

Geographical distribution. This specimen was taken in the Indian Ocean (Lat. 29° 6.2′ S., Long. 89° 39′ E.) by means of the vertical net drawn from 2500 meters.

23. CHUNIELLA (?) ELONGATA (Joubin).

Bull. Mus. ocean., 1906, no. 78, p. 13, fig. 10.

Plate 3, fig. 22.

A small pelagic nemertean, translucent after preservation in formalin, was superficially described by Joubin as a species of Planktonemertes. Although its affinities must remain in doubt until a study is made of its internal organization, Brinkmann ('17a) suggests the possibility of its belonging to the genus Chuniella, where it seems most reasonable to place it provisionally.

This specimen was only 9 mm. in length, and very slender. The body was much flattened, tapering gradually to a slightly developed caudal fin (Plate 3, fig. 22). The proboscis-sheath was about half the length of the body, with numerous intestinal diverticula showing on either side. Sex unknown, perhaps immature.

Geographical distribution. From the North Atlantic (Lat. 34° 02′ N., Long.

12° 21′ W.) Taken by the PRINCESS ALICE expedition in a haul from 4000 meters to the surface.

NECTONEMERTIDAE Verrill.

Trans. Conn. acad., 1892, **8**, p. 446.

Body rather slender, moderately flattened; caudal fin well demarcated from body, often bilobed posteriorly; proboscis-sheath nearly as long as body; intestinal diverticulum without ventral branch; tentacles present in sexually mature males; spermaries numerous, in two groups beside and posterior to brain.

The single genus Nectonemertes is at present the only representative of this family.

Balaenanemertes, in which tentacles also are developed, differs so widely from Nectonemertes in nearly all its other characters that it must be placed in a separate family and is included by Brinkmann ('17a) in the Pelagonemertidae.

NECTONEMERTES Verrill.

Trans. Conn. acad., 1892, **8**, p. 447.

Hyalonemertes VERRILL, Trans. Conn. acad., 1892, **8**, p. 451.

In this genus the body is slender and only moderately flattened; a well-developed caudal fin is distinctly demarcated from the body and often bilobed posteriorly; intestinal diverticula without ventral branch beneath lateral nerve; tentacles present in adult males only.

The species of this genus are sexually dimorphic. At the approach of sexual maturity of the males a pair of long, muscular tentacles develop on the lateral margins of the body just back of the brain. These appendages may reach a length far exceeding the diameter of the body and as they are associated with cephalic spermaries give this sex an appearance very different from that of the female.

Five presumably valid species of this genus are known. Three of these (*N. mirabilis, N. minima, and N. primitiva*) are easily distinguishable by the number and arrangement of the spermaries, and by other well-marked anatomical features, while the other two (*N. pelagica* and *N. japonica*) in the present state of our knowledge are less easily separable anatomically from *N. mirabilis.*

A. With less than 10 pairs of spermaries; caecal diverticula less than 6 pairs .. .. B.
AA. Number of spermaries more than 10 on each side; caecal diverticula 6–8 pairs .... C.
B. With 4 pairs of spermaries; with 4 pairs of caecal diverticula ....*N. primitiva.*
BB. With 6–7 pairs of spermaries; with 3 pairs of caecal diverticula ....*N. minima.*
C. Spermaries, 11–24 pairs; proboscis-nerves, 18–24, color pink, red to orange-red .*N. mirabilis.*
CC. Spermaries, 21–23 pairs; proboscis-nerves, 18 or 19, color deep scarlet .. ..*N. pelagica.*
CCC. Spermaries, about 19 pairs; proboscis-nerves, 22.........................*N. japonica.*

It is evident from the above key that the few males of both *N. pelagica*, from the eastern Pacific, and *N. japonica*, from off the coast of Japan, thus far available for study are intermediate in the characters chosen between the extreme representatives of the numerous specimens of *N. mirabilis*, from the North Atlantic, studied by Brinkmann. This investigator (Brinkmann, '17, '17a) accordingly considers both of the former species as specifically identical with *N. mirabilis*, and it is true that the anatomical structures of all three species appear to be more or less intergrading. Yet the color of *N. pelagica* is brilliant scarlet to crimson, while that of *N. mirabilis* is pink, red, or orange-red. The proboscis-armature of the single specimen in which this apparatus has been studied was different in size from that in *N. mirabilis*. Moreover, accessory stylet-pouches have been found only in *N. pelagica* although they may occur in the other species. Until the females of *N. japonica* are discovered no one can say whether or not important specific distinctions actually exist. The fact that three species of the genus are already known from the North Atlantic should cause hesitation in assuming the specific identity of somewhat similar forms from the opposite side of the world without a more complete anatomical study of both sexes than has yet been possible.

24. NECTONEMERTES MIRABILIS Verrill.

Trans. Conn. acad., 1892, **8**, p. 447 (*non* Bürger); Brinkmann, Bergens mus. aarbok, 1912, no. 9, p. 8; 1915, no. 1, p. 6; Rept. Michael Sars, 1917, **3**, p. 9; Bergens mus. skrift., 1917, ny raek., **3**, no. 1, p. 73, pl. 1, fig. 1–5, pl. 9, fig. 21–25, pl. 10, fig. 1–30; pl. 11, fig. 1–15, Figure 16–20; Coe & Ball, Journ. morph., 1920, **34**, p. 457, pl. 1–5.

Hyalonemertes atlantica VERRILL (*non* BÜRGER), Trans. Conn. acad., 1892, **8**, p. 451.
Nectonemertes grimaldi JOUBIN, Bull. Mus. océan., 1904, no. 20, p. 2; 1906, no. 78, p. 13.

Plate **1**, fig. 3, 4, 5; Plate **3**, fig. 18, 19; Plate **16**, fig. 103–106; Plate **17**, fig. 107–112; Plate **18**, fig. 113–114; Plate **19**, fig. 115–117.

Figure 1, 4, 5, 8, 17, 21, 30, 39, 40.

This species has been so fully described by Brinkmann ('17a) both as to its external appearance and its internal structures, and the anatomy of Verrill's type specimens has been so carefully investigated by Coe and Ball ('20), that it will be necessary to include in this report only such a summary of the essential features as may by comparison help to a better understanding of the other pelagic forms.

Moreover, the admirable anatomical study made by Cravens and Heath ('06) on the closely related Pacific coast species, *N. pelagica*, makes this genus by far the most exhaustively studied of any group of the pelagic nemerteans.

The living worms are quite slender (Plate **1**, fig. 3, 4, 5), with a pair of thin lateral extensions of the body-wall in a region about four fifths the distance from head to posterior end of body, forming a pair of horizontal fins. The body is constricted laterally behind these fins and then broadens at the posterior end to form a distinct caudal fin (Plate **16**, fig. 103; Figure 1, 7, 21). In the male, the body is also constricted just behind the head to form a short nuchal region, behind which a pair of slender tentacles develop at the time of sexual maturity. When fully formed these appendages are about twice as long as the width of the body.

Brinkmann ('17b) shows that the oval form of the head, and the contracted neck-like portion of the body are peculiar to the adult males, and are associated with the development of the tentacles. Furthermore, the horizontal fins and the narrowed base of the caudal fin are indications of fully mature animals of either sex. The caudal fin is subject to great variations in outline, according to the state of contraction, and the posterior border may be sharply bilobed, slightly indented, or entire.

Size. Although one of the specimens examined by Verrill (1892) is stated to have had a length of 64 mm. and a breadth of 13 mm. when measured shortly after preservation, none of the one hundred and sixteen preserved specimens recorded by Brinkmann were nearly as large, the range in length being from 17 to 45 mm. and in breadth from 2.25 to 6 mm., with a thickness of from 1.25 to 2.75 mm. The spasmodic rupture and discharge of the proboscis and the surrounding rhynchocoelomic fluid is often accompanied by a decided flattening of the body, and this shape may be retained after preservation. This would account for the flattened condition of the specimen shown in Plate **1**, fig. 3 and Plate **15**, fig. 102.

Color. All individuals have in life a reddish coloration, the shade being variously described as pink, pale red, deep red, or orange-red, with the brain and lateral nerves of a deeper red, with the tentacles, lateral margins of the body, proboscis, and caudal fin colorless (Plate **1**, fig. 3, 4, 5). Aside from the red, hemoglobin-like coloring of the central nervous system, the coloration of the body is due mainly to the reddish oil-globules in the cells of the intestinal walls.

Integument. The epithelium is mostly dislodged, but where present agrees with the descriptions given by Cravens and Heath ('06) for *N. pelagica*. From a careful examination of the contents in the bottle where two living individuals were killed, and from comparison of specimens taken under various conditions, Brinkmann ('17a) reaches the conclusion that the surface-epithelium is loosened while the worm is being brought from the depths of the sea to the surface and that its loss is not due either to rough handling or the action of the preservative.

The basement-layer consists of a thinner, firmer outer portion and a thicker inner layer, the two sometimes taking a different coloration in staining. The outer surface is covered with deep corrugations for the attachment of the overlying epithelium.

Body-wall. The longitudinal muscles are well developed on the dorsal and ventral surfaces as broad longitudinal bands, but are almost lacking along the lateral borders except in the vicinity of the tentacles and in the caudal fin. Along the median line, both dorsally and ventrally, these bands are greatly reduced in thickness (Plate **19**, fig. 115). The circular muscles occur as a thin but firm layer in all regions of the body. The dorsoventral muscles are extremely abundant in the tentacles and in the horizontal and caudal fins, where they occupy a large proportion of the space within the body-walls (Plate **19**, fig. 116, 117).

The character of the musculature clearly indicates that the animal is a sluggish swimmer, depending for locomotion largely on the movements of the caudal fin, and that it has little capacity for changing the shape of its body or exhibiting the rapid undulations characteristic of most littoral species.

Tentacles. In his original description, Verrill ('92) records a different state of development of these appendages in each of the four specimens which he had for study. The smallest specimen had short, blunt tentacles, only about half as long as the breadth of the head; another had slender, tapering tentacles as long as the diameter of the body, while in the largest they were more than twice as long as the width of the head, with slender, lash-like, somewhat coiled tips.

Brinkmann ('17a) shows that the growth of the tentacles is correlated with the development of the spermaries (Figure 8), as explained more fully on pages 170 and 171.

Proboscis-sheath. The opening of the rhynchodeum is on the dorsomedian part of the tip of the head, and well separated from the mouth. The rhynchodeum is short, with a ciliated epithelium resting upon a fibrous basement-membrane, but without a musculature except for a few circular fibers which form a sphincter at its posterior end.

The proboscis-sheath extends about nine tenths the length of the body, terminating just beyond the base of the caudal fin (Plate **16**, fig. 103). Its wall remains thin and with but few circular muscles for some distance back of the brain, but gradually increases in thickness posteriorly. Excepting its anterior portion, this organ consists of a delicate inner endothelium, resting upon a thin basement-layer, with a thick longitudinal musculature and an even thicker external layer of circular muscles.

Instead of terminating in the body-musculature, as Verrill ('92) states, the proboscis-sheath gradually becomes extremely small towards its posterior end and terminates in a great mass of body-parenchyma entirely free from any part of the body-wall.

Sections through the muscular ring by means of which the proboscis is inserted between the rhynchodeum and the proboscis-sheath show that the outer circular muscular layer of the proboscis is directly continuous with the circular layer of the sheath at the proboscis-insertion. The circular layer of the sheath here lies directly on the basement-layer, and external to this lies the longitudinal musculature. The latter is also continuous with the longitudinal muscles of the proboscis. External to both these layers a few circular fibers are found.

Behind the brain the longitudinal muscles of the sheath pass through the inner circular layer to form the inner muscular layer of the sheath posteriorly. The circular muscles increase in abundance until a short distance back of the head they form a layer exceeding the longitudinal muscles in thickness. The principal portion of the sheath thus consists of two layers of muscles, inner longitudinal and outer circular, with a few spiral fibers interlacing with the latter.

At the point where the proboscis is inserted the longitudinal musculature of the proboscis extends outward through the cephalic tissues as radial muscle-bundles which become inserted in the musculature of the cephalic walls a little more posteriorly. These proboscis-attachment muscles are best developed on the dorsal side of the head but several bundles pass obliquely outward to the ventral and lateroventral portions of the cephalic walls beneath and on either side of the stomach.

Proboscis. The proboscis is somewhat longer than the body. It is composed of the usual outer and inner layers of circular muscles and a much thicker intervening layer of longitudinal muscles, the latter divided into two layers of approximately equal thickness by the nervous plexus and about twenty nerves (Plate 16, fig. 106). Brinkmann ('17a) examined sections of the proboscis from twenty-one specimens in order to determine the range of variation in the number of proboscidial nerves, and found the number to vary from nineteen to twenty-four in the males and from eighteen to twenty-four in the females.

The proboscis shows the usual division into a long anterior chamber with slender papillae crowded with gland-cells; a short central chamber with armature and glandular wreath; and a long, slender posterior chamber lined with columnar, glandular cells.

Armature. Brinkmann ('17a) has described and figured the armature of the proboscis of this species. To his descriptions can be added some details from one of Verrill's original specimens which has been prepared in such a manner as to show the entire stylet-basis. In this specimen the three chambers of the proboscis are remarkably well demarcated (Plate 16, fig. 104). The basis lies just at the constriction separating the middle from the anterior chamber, and projects freely into the posterior end of the lumen of the latter. Including its muscular attachment it closely resembles in shape the crushing claw of a lobster, except that the stylets are on the convex surface. It is much more slender than Brinkmann's figure indicates, the latter evidently having been drawn from an oblique optical section. Its length is 0.072 mm., and its width about .03 mm., and the thickness of the basis proper, excluding its muscular attachments is about 0.019 mm. The three views of the basis shown in Plate 16, fig. 105, indicate that the free surface of the basis is similar in form to the outer surface of the bowl of a narrow spoon which has been slightly twisted spirally. The convex surface is relatively hard and smooth and in it the stylets are imbedded. Optical sections confirm Brinkmann's statement that the stylets are not disposed in a simple row. They are somewhat irregularly placed in two alternating rows. The number appears to be about a dozen, but could not be accurately determined in this specimen because most of them were missing, leaving only oval depressions to mark their former positions. Brinkmann states that there are at least ten.

Accessory stylet-pouches have not as yet been found in this species, although they occur in the closely related *N. pelagica.*

The inner surface of the basis is of very irregular outline, with folds and projections for the attachment of the closely placed muscle-fibers, which are inserted along the entire inner surface (Plate 16, fig. 105). Immediately posterior to the basis is a wreath of deeply staining gland-cells (Plate 16, fig. 104).

At its posterior end the proboscis is provided with a retractor of such strength that when the proboscis is spasmodically extruded, instead of being normally everted, the retractor and the end of the proboscis remain attached to the sheath some little distance in front of the posterior end of the latter.

Alimentary canal. The mouth and proboscis-openings are fairly well separated, the former opening almost terminally and the latter somewhat on the dorsal side of the anterior end of the body. The mouth has the surface epithelium thrown into deep folds, which enable it to be enormously distended during the ingestion of food. It leads almost directly into the stomach with its convoluted glandular walls. At the anterior border of the brain-commissures the stomach becomes narrower and passes gradually into the slender pylorus. The latter becomes much flattened and loses more and more of its gland-cells toward its posterior end, until its walls are lined with ciliated cells exclusively. At a point about 5 mm. from the tip of the head in a mature specimen the pylorus pierces the dorsal wall of the intestine.

The intestinal caecum thus formed is fully as large as the intestine proper, and extends forward nearly to the brain. It is provided with six to eight pairs of very large diverticula, the branches of which extend dorsally above the proboscis-sheath as well as to the lateral margins of the body.

The intestine has upwards of sixty pairs of broad, deeply lobed diverticula which fill most of the space within the body-walls (Plate **16**, fig. 103). Except at the posterior end of the body the diverticula are all irregularly lobed or branched, both vertically and horizontally, and for the most part appear more or less distinctly bilobed distally when seen from the dorsal surface. There is no distinct ventral branch and none of the lobes extend ventrally to the lateral nerve (Plate **19**, fig. 115; Figure 8). The entire diverticulum thus represents the dorsal branch of some of the other pelagic forms. The median lobes of the diverticula from the two sides come almost in contact on the dorsal side of the proboscis-sheath.

Immediately anterior to the caudal fin the diverticula decrease in size and disappear in the short and narrow rectum which opens at the extremity of the body.

Food. Only in a single case is there any evidence as to the kind of organisms upon which these worms subsist. In this particular instance a specimen sectioned by Brinkmann ('17a) showed the remains of a free-swimming crustacean, indicating at least one source of the food-supply.

Vascular system. The three longitudinal vessels are connected by the typical anastomoses at the two ends of the body. The anterior cephalic anastomosis is found on the dorsal side of the rhynchodeum as usual, and the ventral anastomosis lies immediately behind the ventral commissure. From the ventral anastomosis the dorsal vessel originates and enters the rhynchocoel. About a millimeter farther back it leaves the proboscis-sheath, beneath which it extends to its union with the anastomosis of the lateral vessels on the dorsal side of the posterior end of the intestine (Plate 16, fig. 103). This anastomosis usually lies immediately anterior to the nerve-commissure, but both the lateral vessel and the nerve frequently bend dorsally in the same interdiverticular spaces to effect their dorsal unions. The union is usually anterior to the rectum, for two or three pairs of short intestinal diverticula, or sometimes more, are found, posterior to it. Brinkmann ('17a) shows that there is much variation in this respect, however.

Nervous system. Both dorsal and ventral ganglia extend into the lateral nerve, the fibrous central core of which is divided into a smaller dorsal and a larger ventral portion, well separated by ganglion-cells. The ventral core is about three times the diameter of the dorsal core in the middle region of the body but is ten times the diameter of the latter near the posterior end of the body.

The dorsal nerve is relatively small, and is hardly recognizable in the posterior third of the body. It is apparently connected with the rest of the nervous system only by the intermuscular plexus, for it gradually disappears as it approaches the brain.

Many large, cephalic nerves spring from the anterior portions of both ganglia to supply the superficial tissues, including the sense-organs, of the head.

The proboscidial nerves originate as a single large trunk arising from the junction of ventral ganglion and commissure, on each side. This trunk passes directly toward the proboscis-insertion, dividing into about ten branches as it enters the proboscis. The dorsolateral nerves are fairly well developed. Each arises from the junction of dorsal commissure and ganglion and passes posteriorly in the parenchyma lateral to the proboscis-sheath and close beneath the body-musculature. There are frequent connections between these nerves and the dorsal branches of the lateral nerves. They are also connected with the dorsal nerve by means of the intermuscular plexus.

The large tentacular nerves arise from several branches of the dorsal fibrous core of the lateral nerves, branching again as they enter the tentacles to innervate the musculature and integument of these organs (Figure 4).

Sense-organs. The epithelium of the head and to a more limited degree that covering the other regions of the body is provided with bulbous sense-organs, each consisting of a small group of sensory cells surrounded by a sheath of more slender cells. Cravens and Heath ('06) first described these organs and Brinkmann ('17a) figures the nerve with which each of them is supplied. The latter author states that they are not found on the tentacles.

Reproductive organs. Brinkmann in his report on the collections of the MICHAEL SARS expedition ('17) and also in his great monograph on the pelagic nemerteans ('17a) has described in much detail the sexual dimorphism of this species. This investigator had for study by far the most extensive collections of pelagic nemerteans that have ever been brought together. His material contained no less than one hundred sixteen specimens of *Nectonemertes mirabilis* from various stations in the North Atlantic Ocean between 34° and 64° N. Lat. The total number previously known was only ten, eight of which were males.

Of the one hundred and sixteen specimens in these collections, thirty-two were provided with more or less well-developed tentacles and with the cephalic gonads characteristic of the males, while eighty-four were without these appendages. Of the latter, sixty-three were easily recognized as females, while the remaining twenty-one specimens were all small and needed more careful examination to determine the sex. Six of them proved to be young males with the spermaries in an early stage of development, but the other fifteen were quite immature and appeared to be sexually undifferentiated.

The size of the tentacles in the males sufficiently mature to develop these appendages varied from slight traces of elevations of the body-walls on the sides of the head to a length of 10 mm. The developmental stages of these organs form a graded series perfectly correlated with the state of maturity of the spermaries (Figure 8).

A worm in the first stage, for example, with a body-length of about 21 mm. had but slight indications of the tentacles. In this stage the spermaries consisted simply of thin-walled sacs, without other sexual elements than the primitive spermatogonia merely imbedded in the walls. The musculature was represented merely by scattered nuclei imbedded in a more or less continuous protoplasmic mass, the whole being covered by a delicate sheet of connective tissue.

In the second stage, when the projections which are to form the tentacles have reached an elevation of about one millimeter, the cells which are to form the musculature have assumed a peripheral position surrounding the more numerous spermatogonia. At this stage also the first spermatocytes appear.

A worm in the third stage measured about 34 mm. in length, with tentacles 4 mm. long. The spermaries are here provided with a well-developed musculature and the processes of spermatogenesis have progressed to the stage where the spermatids are formed, and in some cases the unripe spermatozoa are imbedded in their cytophores. The sexual cells have multiplied to such an extent that they fill up most of the lumen of the spermary.

In full sexual maturity, which may occur with a body-length of about 40 mm., the tentacles are fully formed and reach a length of 6 mm. or more. The spermatogonia have now mostly disappeared in the formation of spermatocytes, and the spermaries are filled with spermatocytes, spermatids, and spermatozoa in various stages of maturity.

Spermaries. Situated on each of the lateral borders of the head is an enlarged group of pyriform gonads, containing an average of about fifteen in each group (Plate 16, fig. 103). The number of spermaries is much more variable than the earlier observations on the species would indicate. Twelve males selected at random by Brinkmann ('17a) showed a range of from eleven to twenty-four on either side of the head. This gave a total for each animal ranging from twenty-four to forty-seven, but in only two of the specimens did the number exceed forty. Curiously enough, there appears to be a certain asymmetry in these organs, for only in two of the twelve animals was the number the same on both sides. In all the others, the number on the left side exceeded that on the right, the excess varying from one to six.

The ducts from the gonads open on the ventral surface of the head, each at the summit of a small papilla projecting slightly above the general surface of the body (Plate 17, fig. 107, 112).

When fully developed, the spermaries fill the major portion of the space within the body-walls in their vicinity, crowding the diverticula of the intestinal caeca close up against the dorsal wall of the body and almost obliterating its lumen. The lateral nerves and blood-vessels are likewise crowded out of their normal positions and come to lie in the dorsal half of the body (Plate 17, fig. 107). Each gonad is surrounded by a thick layer of spiral muscles which doubtless serve for the forcible ejection of the spermatozoa at the time of pairing.

In its general shape, the spermary resembles a retort with its neck directed ventrally and laterally (Plate 18, fig. 113, 114). The germinal cells occupy only the body of the retort-shaped organ, the neck serving as a duct for the discharge of the spermatozoa. At about the middle of the neck the muscular wall is terminated sharply by a narrow constriction which marks the end of the gonad proper. The opening in this constriction leads into a spacious chamber, lined with a single layer of cuboidal epithelium. This chamber serves as a seminal vesicle, and into it the ripe spermatozoa collect previous to their discharge from the body (Plate 18, fig. 114).

Ovaries. In the female there is a single row of about twenty to thirty ovaries situated on the dorsal side of the lateral nerve between the intestinal diverticula on each side of the body. Each of these gonads produces but one or two large ova, as is the case with most other pelagic nemerteans.

The ovaries extend forward as far as the posterior portion of the intestinal caecum, the most anterior ones lying between its diverticula. Posteriorly they reach nearly to the base of the caudal fin.

In an early stage of growth, the ovary appears as a hollow sac with the lumen bordered by a protoplasmic syncytium containing two or more layers of nuclei. The latter are of two types, those of the follicle-cells being small and deeply staining, while those of the primitive ova are much larger and granular. With the further growth of the ovary, the egg-cells increase in size and become completely surrounded by the syncytium of follicle-cells. The ovum situated farthest from the oviduct grows more rapidly than the others and receives an abundance of round or ovoid yolk-granules formed by the follicle-cells and passed by protoplasmic connections into the egg-cell. The mature egg absorbs all trace of the follicular syncytium in its neighbourhood, utilizing this material in the elaboration of yolk, with which its cytoplasm is densely packed. It measures more than a millimeter in diameter, or more than half the thickness of the body of the worm.

All the primitive ova except the definitive egg-cell become abortive. During the growth of the egg, the oviduct is formed as far as the basement-layer of the body-wall, very much as in *N. pelagica* (Plate 19, fig. 119). It does not open through the epithelium, however, until the egg is being discharged, when the epithelium of both oviduct and body is ruptured. Such of the abortive ova as are not absorbed may be discharged with the ovum, but sometimes a few cells near the oviduct remain behind, but it is uncertain whether these may regenerate a new ovary.

Reproduction in this species is shown by Brinkmann ('17a) to be quite independent of the season of the year, for surface-conditions do not alter the environment of these bathypelagic creatures.

Habits. The worms of this species are so extremely hardy that they frequently survive the enormous changes in pressure which occur when they are brought to the surface from their natural habitat 500 to 2000 meters below. Such living animals swim freely in all directions, vertically as well as horizontally, in a glass of sea-water. They move by contractions of the caudal fin together with undulations of the body. They continue to swim even when badly mutilated and may even survive a short exposure to the air.

Habitat. In the MICHAEL SARS deep-sea expedition it was possible to determine with a great deal of accuracy the depth at which this species lives. This procedure consisted of lowering numerous nets to different depths and drawing them horizontally for several hours simultaneously (Figure 49).

By this ingenious method selective collections are made of the organisms living in the various depth-zones, for those forms which are accidentally caught while the nets are being lowered or hauled to the surface will be immediately identified as belonging to a more superficial habitat by their greater abundance in the more superficial nets. It has thus been shown conclusively that this species lives in a rather definite layer of water having a temperature of 6° or less and a salinity not exceeding 35°. This layer is found from 500 to 2000 meters below the surface in the North Atlantic where the species was collected. The depth of greatest frequency was about 1300 meters (Figure 50).

Geographical distribution. Seven specimens collected by the U. S. Fish Commission came from the North Atlantic Ocean at four stations between about 37° to 42° N. Lat., and 50° to 73° W. Long., the depth of water in this region being from 600 to 1700 fathoms. Two specimens from the INGOLF expedition of 1895 were taken at Lat. 62° 49′ N., Long. 26° 55′ W. The THOR expedition, 1904–1906, collected twelve specimens between Lat. 48°–62° N., Long. 13°–17° W. Eight were taken by the TJALFE expedition, 1909, at Lat. 60°–64° N., Long. 48°–56° W. The MICHAEL SARS expedition, 1910, took no less than eighty-two specimens of this species at Lat. 34°–58° N., Long. 11°–51° W., and the ARMAUER HANSEN expedition, 1913, took thirteen at Lat. 54°–60° N., Long. 20°–31° W. To this total of one hundred and twenty-four specimens may be added one or two from the same general region collected by the PRINCESS ALICE expeditions, 1904, and superficially described by Joubin as a distinct species.

The regions covered by these collecting stations comprise the entire width of the North Atlantic Ocean and extend from 34°–64° N. Lat., or from off the coast of northwestern Africa to the latitude of southern Greenland (Plate **30**).

25. NECTONEMERTES JAPONICA Foshay.

Zool. anz., 1912, **40**, p. 50.

Six specimens, all of which were males, have been collected off the coast of Japan. One of these measured 23 mm. long, 7 mm. wide and 2 mm. thick. The contracted tentacles were 4 mm. long. In two of the specimens the proboscis was intact, but no traces of the armature were discovered. There are approximately twenty-two proboscidial nerves. Intestinal diverticula are numerous, and the intestinal caecum bears eight pairs of diverticula. The males have about nineteen spermaries in an irregularly shaped elongated group on each side of the head in front of the tentacles.

Geographical distribution. Thus far known only from near Misaki, Japan; depth not recorded, but that the specimens were free swimming is indicated by the fact that they were accompanied by Hydromedusae and Pteropoda.

Brinkmann ('17a) places this form with *N. mirabilis*, but further anatomical study, including both sexes, is necessary before assuming a specific identity of forms which may prove to show marked differences in the female sex, especially since they appear to be so widely separated geographically. It is not impossible that a study of the proboscis may reveal characteristic distinctions between these forms.

26. NECTONEMERTES PELAGICA Cravens and Heath.

Zool. jahrb. Anat., 1906, **23**, p. 337, pl. 21, 22.
Plate **1**, fig. 6; Plate **19**, fig. 118, 119.
Figure 1, 11, 12, 15, 28, 84–86.

A species of Nectonemertes from off the west coast of North America resembles *N. mirabilis* so closely in general appearance and in most of its anatomical features that the two were considered by Brinkmann ('17a) to be specifically identical. The color, however, appears to be considerably different and a study of the female indicates that there are several minor anatomical peculiarities of the Pacific form which would seem to warrant its retention as a valid species. Additional material to determine the extent of variation is required in order to decide the matter positively.

Shape and size. Five males carefully studied and fully described by Cravens and Heath ('06) were all adult, with fully mature gonads and well-developed tentacles. The type specimen measured 41 mm. long, 7.2 mm. wide, and 2.5 mm. in thickness. The length of the contracted tentacles was about 6 mm. A single female contained in the ALBATROSS collections was 18 mm. in length, 3 mm. wide, and about 2 mm. thick. The female shown on Plate **1**, fig. 6, was about 54 mm. long and 5 mm. wide. The drawing shows that it was made when the worm was extended to its extreme length, indicating that when contracted or after preservation the body would be considerably shorter and somewhat wider.

The caudal fin is well developed, and the lateral margins of the body immediately anterior to it are also much flattened and prolonged into a pair of horizontal fins.

Color. The mature males are described by Cravens and Heath ('06) as being brilliant scarlet or flame-scarlet, while those of *N. mirabilis* are salmon-colored, pink, or reddish yellow. The female, as shown by a drawing made from the living animal by Alexander Agassiz (Plate 1, fig. 6) is deep scarlet like the male, with colorless head and caudal fin. The color is evidently associated with the intestinal diverticula. A pair of faint reddish spots on the head evidently represent the brain-lobes with their hemoglobin-like pigment.

Proboscis-sheath and proboscis. The proboscis-sheath agrees closely with that of *N. mirabilis.* The armature of the proboscis, however, indicates a specific distinction between the two species, as described below.

As shown in Figure 11, the proboscis of *N. pelagica,* as indicated by the only specimen thus far secured in which this organ was retained, was much contracted and somewhat exceeds the body in length. It is attached posteriorly by two slender retractor-muscles which are fastened to the walls of the sheath about 2 mm. anterior to the posterior end of the latter. The rhynchocoel is very narrow posterior to the attachment of the retractors.

The middle chamber, bearing the stylet-basis is about two thirds the distance from anterior to posterior end, so that the posterior chamber must have extremely elastic walls in order to allow the armature to come to the end of the fully everted organ.

Cravens and Heath found evidence of nineteen proboscidial nerves; there were eighteen in the female. Brinkmann ('17a) found the number to vary from eighteen to twenty-four in *N. mirabilis.*

The stylet-basis is crescentic in outline, with the posterior end slender and the anterior end broadened (Figure 12). The length of the basis in this specimen is .0345 mm., and its width about .015 mm. In contrast to these figures the basis of *N. mirabilis* is fully double as long, measuring .072 mm. in length, in the only specimen available for study. The body-length of that specimen, however, was double that of the specimen of *N. pelagica,* the proboscis of which was measured. There is doubtless some increase in the size of the basis with growth in body-size, but the correlation is as yet undetermined. On the convex face of the basis there are about a dozen stylets, arranged somewhat irregularly in two more or less alternating rows, as in *N. mirabilis.*

In addition to the stylets on the basis the proboscis of the female was provided with at least three minute pouches, each containing four to seven tiny accessory stylets, the whole being accompanied by a broad wreath of deeply staining gland-cells (Figure 12). Accessory stylets have not thus far been found in *N. mirabilis.*

About two millimeters of the anterior end of the posterior chamber is lined with irregular papillae composed of slender cells filled with a granular secretion which is unaffected by the ordinary stains, while posterior to this region the glandular contents of the cells stain intensely. In this specimen the epithelium of the entire anterior chamber except for about one millimeter next the middle chamber had been dislodged.

Digestive system. As so fully described and excellently figured by Cravens and Heath ('06) for the male, the intestinal caecum is very large, extending anteriorly nearly to the brain and being provided with about seven pairs of large diverticula (Figure 86). The intestinal diverticula are irregularly lobed and divided into numerous short branches in both vertical and horizontal planes. The dorsal branch sends one large lobe dorsally beside and above the proboscis-sheath and another laterally to the margin of the body, but the ventral branch is short and in no case extends beyond the lateral nerve (Figure 15). The number of intestinal diverticula shown in the drawing by Cravens and Heath is somewhat more than forty (Figure 84). The female studied had about thirty pairs.

Reproductive organs. The gonads of the male are fully described by Cravens and Heath. As shown in Figure 85 there are somewhat more than twenty flask-shaped spermaries in an irregular, elongated group on each side of the head anterior to the tentacles.

The female, hitherto undescribed, has a single row of twenty to twenty-four ovaries alternating with the intestinal diverticula on each side of the body (Plate **19**, fig. 118). The ovaries lie on the median dorsal side of the nerve-cords. Each organ is retort-shaped, with a single large ovum in the expanded portion and other abortive ova filling up the neck. The body of the ovary is situated somewhat medially to the nerve-cord, its neck extending laterally above the nerve and then bending toward the ventral surface of the body. The opening of the oviduct thus comes to lie immediately lateral and ventral to the nerve-cord. As the growth of the single large ovum proceeds the ovary is gradually extended along the lateral border of the nerve-cord, eventually occupying a more lateral position (Plate **19**, fig. 119).

The young ovum has a single large nucleolus, but with the accumulation of yolk this primary nucleolus disintegrates, to be replaced by numerous smaller nucleoli situated immediately internal to the nuclear membrane. The chromosomes become arranged in slender moss-like threads extending through the central portions of the large germinal vesicle (Plate **19**, fig. 119). The abortive eggs are in part absorbed by the definitive ovum, while others remain in an apparently primitive condition along the walls of the oviduct (Plate 19, fig. 119).

Geographical distribution. Five males are recorded by Cravens and Heath ('06) from the Pacific coast of North America; off Monterey Bay, California, where the water has a depth of about 1000 meters, and off the southern coast of California (Station 4393), where the depth was over 4000 meters. A single female was taken by the Northwestern Pacific expedition, 1906, at Station 4958, off Cape St. James, Queen Charlotte Islands (Lat. 52° 02′ N.; 132° 53′ W.), May 19. Depth about 3200 meters. One large (1.7 m.) net and two small (36 cm.) nets were drawn at about 600 m. (800 m. wire out) for twenty minutes and then hauled to surface with the nets open.

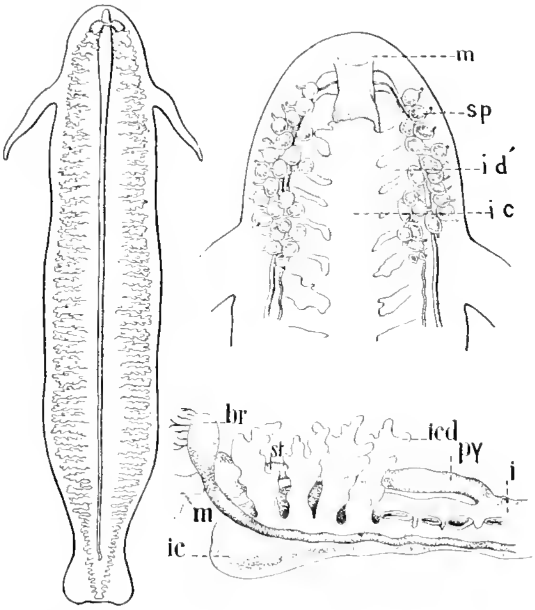

FIG. 84–86.— *Nectonemertes pelagica* Cravens & Heath. Fig. 84. Outline of body of mature male, showing tentacles somewhat contracted and arrangement of intestinal diverticula. Fig. 85. Ventral surface of head of mature male, showing arrangement of spermaries (*sp*); *m*, mouth; *ic*, intestinal caecum; *id′*, diverticula of same. Outlines of base of tentacles are also shown. Fig. 86. Side view of anterior portion of alimentary canal, showing the mouth (*m*), stomach (*st*), pylorus (*py*), and intestine (*i*), with the large caecum (*ic*) extending forward nearly to the brain (*br*) and sending its branched diverticula (*icd*) to the dorsal side of the proboscis-sheath. (After Cravens and Heath '06).

Another female, evidently of this species, although the specimen was lost after a colored drawing was made by Alexander Agassiz, was taken by the Albatross, 19 November, 1904, at Station 4669 in a net drawn at a depth of about 600 m. This locality is in the Pacific Ocean off the coast of Peru (Lat. 12° 13′ S., Long. 80° 25′ W.); the depth is here about 5200 m., but the nets were lowered to about 600 m. only. The surface-temperature was 67° F. The bottom-temperature was not recorded but at neighbouring stations it was from 35.1° to 35.4° F., while the thermometer at 600 m. registered from 44.6° to 45.3° F.

These records indicate that this species has its habitat in a deep and cold-water layer similar to that of the closely related *N. mirabilis* and that the geographical range extends from south of the equator to above 50 degrees north latitude.

27. Nectonemertes minima Brinkmann.

Bergens mus. aarbok, 1915, no. 1, p. 6; Rept. Michael Sars, 1917, **3**, p. 13; Bergens mus. skrift., 1917, ny raek., **3**, no. 1, p. 102, pl. 11, fig. 16–19, Figure 22, 23; Deutsch. südpol. exped. 1918, **16**, Zool., **8**, p. 290.

Hyalonemertes atlantica Bürger, Wissens. ergebn. Valdivia, 1909, **17**, p. 217.

Figure 87–89.

The general form of the body is rather more slender than in the other species of the genus and the tentacles are relatively larger. The worms average four to seven times as long as broad, and when mature, are evidently much smaller than those of any of the species of the genus hitherto described, for sexually mature specimens were but 11 to 19 mm. in length, with a breadth of 4 mm. or less with a thickness not exceeding 1.25 mm. (Figure 87, 88).

The living animals are yellowish red in color, with the intestinal canal and diverticula deeper red.

Tentacles. The tentacles which are situated about 2 mm. back from the anterior end of the head reach a length of 4 mm. Here as in *N. mirabilis* there is a close correlation between the state of maturity of the gonads and the development of the tentacles. In a specimen only 8 mm. in length, in which the spermaries had just begun to develop, the tentacles had not formed at all, while a specimen 11 mm. long had short tentacles and in one 15 mm. long both these appendages and the spermaries were fully developed (Figure 87).

Proboscis-sheath and proboscis. The rhynchocoel extends almost the entire length of the body. Its wall consists of an inner layer of circular muscles and an outer layer of longitudinal fibers at its very anterior end, but in the brain-region and posteriorly the layers are reversed. The proboscis is about twice as long as the body, with eighteen nerves and a very rudimentary basis bearing only a few extremely minute stylets.

Digestive system. The intestinal caecum bears three pairs of diverticula, and the intestine about sixty pairs. They are unbranched.

Reproductive organs. The males of this species are easily distinguished from those of *N. mirabilis*, and *N. pelagica* in having only five, six, or seven spermaries on each side of the head. These are situated in a single row on each side extending from the posterior border of the brain backward to the base of the tentacle (Figure 89). Each spermary has a slender duct leading to a minute papilla on the ventrolateral border of the head. There are about twenty-five pairs of ovaries situated on the dorsomedial aspects of the lateral nerves. The oviducts open lateral to the nerve-cords.

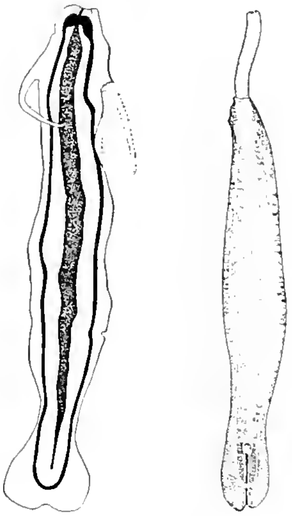

FIG. 87, 88.—*Nectonemertes minima* Brinkmann. Fig. 87. Mature male showing tentacles, brain, proboscis-sheath; *sn*, lateral nerves and caudal fin. (After Brinkmann, 1918). Fig. 88. Female, with partly extended proboscis. (After Brinkmann, 1917a).

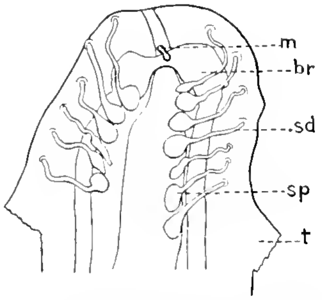

FIG. 89.—*Nectonemertes minima* Brinkmann. Outline of ventral surface of head of mature male, showing position of spermaries (*sp*), with their long spermatic ducts (*sd*); *br*, brain; *m*, mouth; *t*, base of tentacle. (After Brinkmann, 1915).

Geographical distribution. The four specimens of the German South-Polar expedition were taken in the Atlantic Ocean, off the west coast of Africa (Lat. 35° 39′ S., Long. 8° 16′ E.; Lat. 0°, 46′ N., Long. 18° 59′ W.), both in vertical hauls from 3000 meters to surface. The female taken by the VALDIVIA expedition and which was fully studied by Bürger came from very near the latter station (Lat. 0° 20′ N., 6° 45′ W.), also in the vertical net from 3500 meters. Three females from the MICHAEL SARS expedition came from the North Atlantic (Lat. 39° 30′ N., 49° 42′ W.; 56° 33′ N., 9° 30′ W.; 57° 41′ N., 11° 48′ W.), from a depth of from 550 to 1400 meters. The species is thus widely distributed, ranging in the eastern Atlantic from 57 degrees north latitude to 35 degrees south latitude.

28. NECTONEMERTES PRIMITIVA Brinkmann.

Rept. Michael Sars, 1917, **3**, p. 13; Bergens mus. skrift., 1917, ny raek., **3**, no. 1, p. 97, pl. 12, fig. 1–15, Figure 21.

Nectonemertes mirabilis BÜRGER (*non* VERRILL), Wissens. ergebn. Valdivia, 1909, **17**, p. 211.

Figure 90–93.

The body in life is quite slender, with nearly parallel margins (Figure 90), but when contracted, as is usually the case with preserved specimens, may become short, broad, and relatively thick (Figure 91–93). The head of the male is rounded, with a deep constriction just anterior to the tentacles. The broad, well-demarcated, caudal fin is distinctly bilobed posteriorly. The length of the three specimens known at present was from 12–19 mm., the width 3–4 mm., with a thickness of 2 mm. In a male 12 mm. long the tentacles measured 1.5 mm., while in a fully mature male measuring 19 mm. these appendages were probably 7 to 10 mm. long (Figure 90).

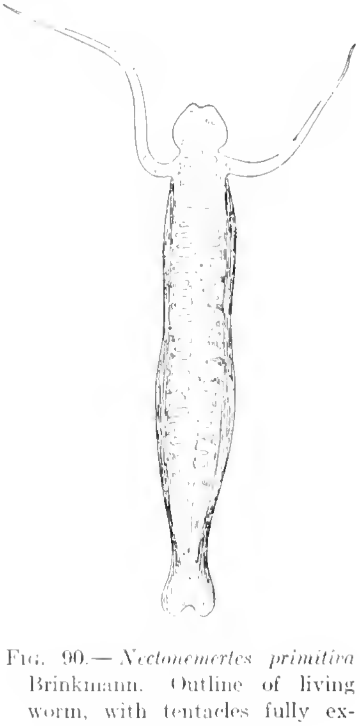

FIG. 90.—*Nectonemertes primitiva* Brinkmann. Outline of living worm, with tentacles fully extended. (After Bürger, '09).

Color. Bürger states that the body is translucent in life, with the intestine and its diverticula and probably the spermaries more opaque, and yellowish red in color. The caudal fin is said to have some brown pigment.

Proboscis-sheath and proboscis. The proboscis-sheath, as in the other species of the genus, is provided with an inner longitudinal and an outer circular layer of muscles except at the very anterior end, where the relations are reversed.

Digestive system. In the absence of an oesophagus, the mouth opens directly into the stomach, and the latter into the pylorus as in other forms.

The intestine begins in the region of the tentacles and has about fifty pairs of diverticula, while the caecum has four pairs.

Reproductive organs. The males have four to six spermaries in a single row on each side. They lie between and beneath the caecal diverticula beneath and just back of the brain (Figure 92). The sperm-ducts lead anteriorly, opening beneath and in front of the brain. The female has about ten pairs of ovaries each of which usually produces but a single egg.

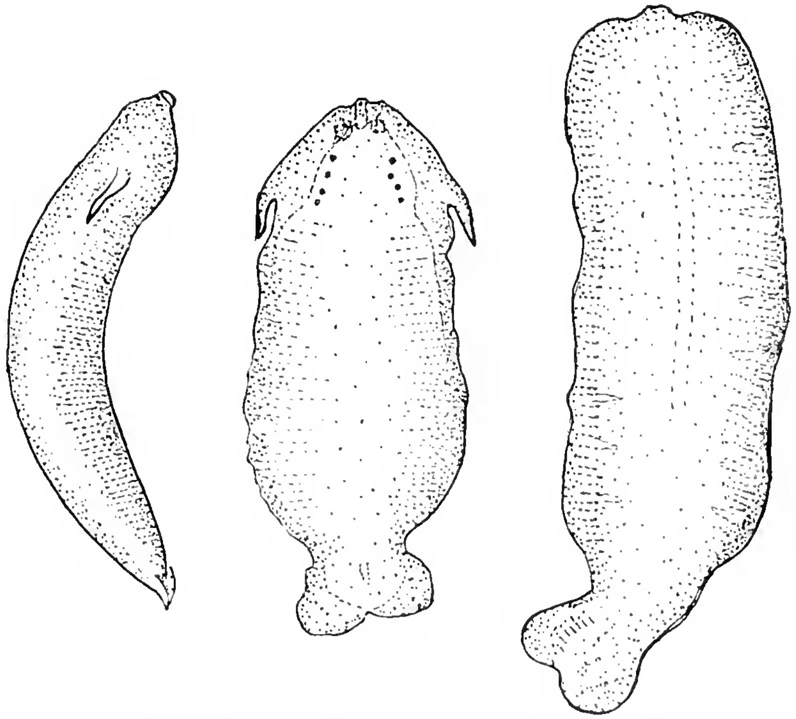

FIG. 91–93.—*Nectonemertes primitiva* Brinkmann. Somewhat contracted after preservation. Fig. 91. Side view of mature male. Fig. 92. Ventral view of same, the four pairs of small dark spots between the tentacles indicating the spermaries. Fig. 93. Ventral side of female. × 7. (After Brinkmann, 1917a).

Geographical distribution. The specimen studied by Bürger was collected by the VALDIVIA expedition in the Atlantic off the west coast of French Congo (Lat. 3° 55′ S., Long. 7° 48′ E.) in a vertical haul from 3000 meters. Two specimens collected by the MICHAEL SARS expedition came from the North Atlantic (Lat. 31° 20′ N., Long. 35° 7′ W. and Lat. 34° 59′ N., 33° 1′ W.) at about 666 and 200 meters respectively.

Armaueriidae Brinkmann.

Rept. Michael Sars, 1917, **3**, p. 16.

Body broad anteriorly, somewhat narrowed at posterior end which bears a fairly well demarcated caudal fin; anterior end of body (at least in preserved specimens) bent dorsally, bringing mouth to terminal position and rhynchodeal opening to dorsal side of head; proboscis-opening on dorsal side of head; proboscis-sheath limited to anterior half of body; intestinal diverticula without ventral branch; dorsal vessel extends nearly entire length of body but does not enter rhynchocoel; spermaries in one or more rows on each side of head, extending posteriorly behind brain.

The single genus Armaueria has hitherto been described, but a new form taken in the northwest Pacific belongs to the same family but is generically distinct.

The two genera may be distinguished as follows:—

A. Intestinal diverticula unbranched; spermaries in a single irregular row on each side. . . . *Armaueria.*
AA. Intestinal diverticula irregularly lobed and branched; spermaries in two or more irregular rows on each side of body; irregularly hermaphroditic. . . . . *Proarmaueria.*

Armrueria Brinkmann.

Rept. Michael Sars, 1917, **3**, p. 16.

Body broad anteriorly, nearly cylindrical in anterior half, flattened, tapering to a rather narrow caudal fin; proboscis-sheath short, limited to anterior half of body, but proboscis exceeds the body in length; wall of proboscis-sheath composed of inner and outer circular layers with a middle layer of longitudinal fibers; intestinal diverticula numerous, unbranched; dorsal anastomosis of cephalic vessels lacking; spermaries in an irregular row on each side of body.

Only a single species, *A. rubra*, is as yet known.

29. Armaueria rubra Brinkmann.

Rept. Michael Sars, 1917, **3**, p. 16; Bergens mus. skrift., 1917, ny rack., **3**, no. 1, p. 105, pl. 1, fig. 6, pl. 13, fig. 1–12, Figure 24.

Figure 94–96.

This is a minute form, resembling Pelagonemertes in shape and appearance. The four specimens described by Brinkmann measured, after preservation, from 5.3 mm. long by 2 mm. in width to 9.5 mm. long by 7 mm. in greatest width (Figure 94, 95).

Color. The body is deep red in color, except for the lateral margins of the posterior two thirds and the caudal fin, which are translucent and colorless. The brain is darker red.

Proboscis-sheath and proboscis. Due to the dorsal bending of the head the proboscis-pore lies dorsal to the terminal portion of the head, and consequently is well separated from the mouth. The proboscis-sheath is generally limited to the anterior half of the body but the proboscis exceeds the body in length. There are fourteen proboscidial nerves, but only seven of these are conspicuous towards the posterior end of the anterior chamber. The armature is of the Drepanophorus-type, with a small basis and minute stylets. The retractor is inserted at the posterior end of the rhynchocoel. The muscular wall of the anterior end of the sheath is composed of an inner circular and an outer longitudinal layer, but behind the brain the longitudinal layer penetrates the circular layer but the fibers of these layers are not interwoven.

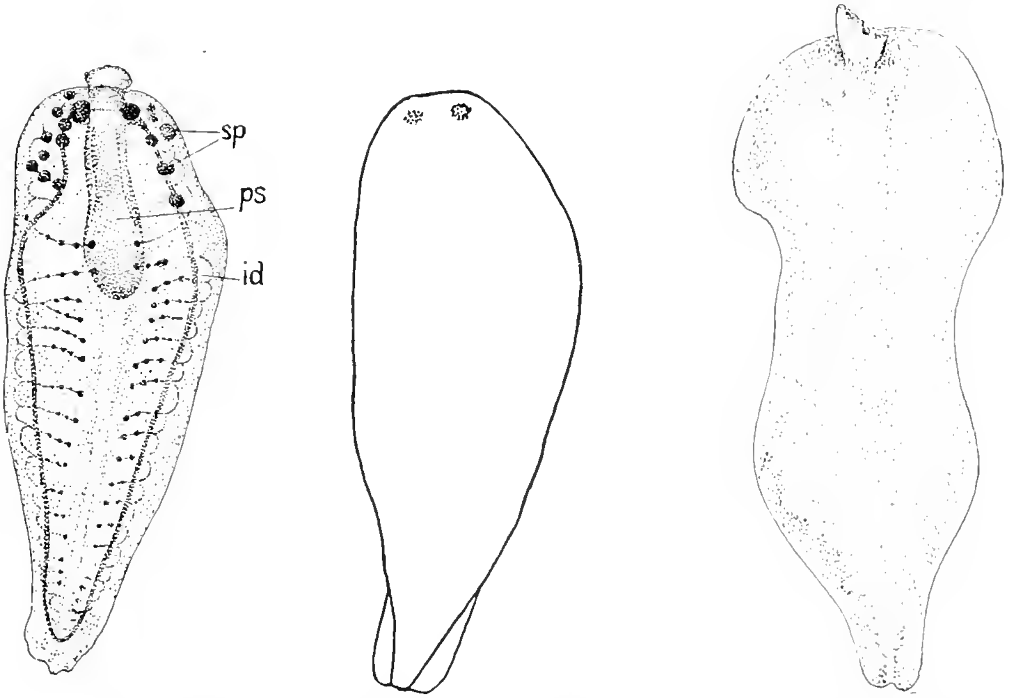

Fig. 94, 95.—*Armaueria rubra* Brinkmann. Fig. 94. Male from ventral surface, showing spermaries (*sp*), intestinal diverticula (*id*) and extent of proboscis-sheath (*ps*). × 8. Fig. 94a. Outline of body, showing caudal fin. Fig. 95. Female from dorsal surface, showing dorsal position of proboscis-opening. × 10. (After Brinkmann, 1917a).

Digestive system. The mouth opens directly into the stomach, from which a short pylorus leads into the broad intestine. The latter has about twenty-five pairs of unbranched diverticula, while the short intestinal caecum has but a single pair.

Vascular system. The dorsal cephalic anastomosis is wanting; the dorsal vessel extends from the ventral cephalic anastomosis to the posterior anastomosis above the rectum and in one specimen a tiny vessel continued posteriorly to the extremity of the caudal fin.

Reproductive organs. The spermaries form an irregular row near the lateral nerves (Figure 94, 96) on each side of the cephalic region, the sperm-ducts opening lateroventrally. The number is from eight to twelve on each side. No muscle-cells occur in the walls of the spermaries. The single known female had about eight pairs of ovaries, with oviducts in the vicinity of the lateral nerves. Some of the oviducts were situated medially to both lateral vessel and nerve, others between these two organs and still others lateral to both.

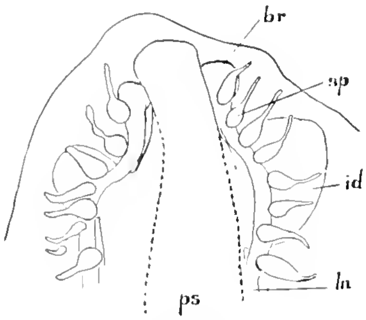

FIG. 96.—*Armaueria rubra* Brinkmann. Outline of anterior portion of body of male, showing position of spermaries (*sp*); *br*, brain; *id*, caecal diverticulum; *ln*, lateral nerve; (*ps*) proboscis-sheath. (After Brinkmann, 1917a).

Geographical distribution. But four specimens of this species have been collected; all from the North Atlantic between 45° and 55° N. Lat. and 25° to 43° W. Long., at a depth of from 800 to 1600 meters (Plate 30).

PROARMAUERIA, gen. nov.

Two specimens of a new genus of the Armaueriidae from the northwest Pacific occurs in the ALBATROSS collections. This genus, for which the name Proarmaueria is suggested, may be diagnosed as follows:—

Body broad and flattened, tapering somewhat toward posterior end; with a fairly well-developed caudal fin; proboscis-sheath limited to anterior half of body; intestinal diverticula rather numerous, each with many irregular lobes and short branches, but ventral lobe does not reach lateral nerve; spermaries in two or more irregular rows on each side of head, extending posteriorly about one third the length of the body; irregularly hermaphroditic.

In one important respect the two specimens suggest that they may actually represent two distinct species, for in specimen A there were ten large proboscidial nerves with several small ones, while in specimen B there were fourteen of these nerves, of which seven large ones alternated in some regions with seven of smaller size. It is quite unusual for pelagic species to show so wide a divergence in these characters, but until additional material is secured it seems best to recognize but a single species, for which the name *pellucida* is suggested on account of the translucency of the body.

30. PROARMAUERIA PELLUCIDA, sp. nov.

Plate **20**, fig. 120–124; Plate **21**, fig. 125–132; Plate **22**, fig. 133–138; Plate **23**, fig. 139–143.

Figure 1.

The two specimens on which this description is based were mature males, each with one or more hermaphroditic gonads. One of the specimens (A) measured after long preservation 11 mm. in length, 5.5 mm. in width and a little more than 2 mm. in thickness, while the other (B) was 16 mm. long and 4.5 mm. wide. The body is broad and rather flat (Plate **20**, fig. 120–122), narrowed somewhat toward the posterior end, which is provided with a caudal fin having thin lateral outgrowths. The proboscis was in its natural position in one specimen, while in the other it was partially everted.

The color in life is unknown, but the presence of deep yellow secretion globules in the intestinal epithelium suggests a yellow intestinal tract. After preservation in formalin the body was pellucid and of a firm gelatinous consistency.

The anterior end of the body is bent dorsally in both specimens, bringing the mouth to the terminal margin of the head, while the proboscis-opening, which is well separated from the mouth, lies on the dorsal surface of the head (Plate **20**, fig. 120–122). The brain and lateral nerves, and the digestive and reproductive organs are correspondingly thrown out of their normal horizontal positions in the body. It thus happens that a section transverse to the longitudinal body axis shows an oblique, more or less longitudinal section of brain, lateral nerves, stomach, and proboscis (Plate **21**, fig. 129). In a series of sections cut as nearly as possible in a plane transverse to the longitudinal axis of the body the ventral brain-lobes and commissure are encountered many sections anterior to those of the dorsal side, and the lateral nerves are cut before the brain is reached (Plate **21**, fig. 129).

Body-walls. The cephalic musculature is limited, as in Pelagonemertes, to a thin layer of scattered muscle-bundles separated by connective tissue-fibers. More posteriorly the longitudinal muscles become increased in thickness to form a broad horizontal muscular plate along the dorsal side of the body, with a similar plate on the ventral side. The musculature along the lateral margins remains thin throughout the body. Dorsoventral muscles are little developed, except posteriorly.

The superficial epithelium had been dislodged except at the tip of the head, where it shows the usual arrangement of ciliated and glandular cells.

Parenchyma. The head contains large areas filled with gelatinous tissue, doubtless more or less encroached upon in the case of the males by the development of the spermaries. In the middle and posterior portions of the body the intestinal diverticula leave more space for parenchyma than in many pelagic forms, particularly toward the lateral margins and beside the proboscis-sheath.

Proboscis-sheath. This organ is a swollen, oval sac, extending about halfway toward the posterior extremity (Plate **20**, fig. 120). Its walls are relatively thin, with circular and spiral muscular fibers predominating. There is an inner layer of circular fibers, a more or less interrupted middle layer of isolated longitudinal muscle-bundles, followed by an outer layer of spiral and circular fibers. But these layers are by no means independent, for numerous spiral fibers pass obliquely in all directions between inner and outer circular layers, and these divide the longitudinal layer into its numerous separate bundles. As Brinkmann ('17a) shows for *Armaueria rubra* the longitudinal layer is external to the single circular layer for a very short distance at its most anterior end, but a very short distance farther back forces its way into the latter to form a more or less interrupted middle layer. In general, the outer part of the circular layer is about half as thick as the inner part which borders the rhynchocoel.

Since the brain and proboscis-attachment are very near the proboscis-pore the rhynchodeum is unusually short. The proboscis is inserted in the tissues of the head by a thick ring of muscles, but the strong muscular bands which in many species form the attachment-muscles for anchoring the insertion-ring in its place are absent. A few muscular fibers from the insertion-ring follow the rhynchodeum forward.

Near its posterior end the broad proboscis-sheath in one of the specimens is contracted abruptly into a narrow tube with thick walls. Into this the proboscis extends and is attached by a thick retractor-muscle to the end of the sheath, the fibers of the two organs being closely interwoven. The end of the sheath bends dorsally and is pressed against the musculature of the body-wall, but there is no muscular connection between them, for the sheath ends freely in a condensed mass of parenchyma. In the second specimen, in which the proboscis is in its normal position, the sheath is broadly oval posteriorly (Plate **20**, fig. 120–122).

Proboscis. As stated above, the rhynchodeum opens dorsally a short distance behind the anterior margin of the head. The proboscis is thick anteriorly, but is rather short and but little coiled in the rhynchocoel (Plate **20**, fig. 120). The anterior chamber is provided with a very thick basement-layer, much as in Pelagonemertes, but the inner, rhabdite-bearing epithelium is retained only in the most posterior part of the chamber. There were ten well-demarcated and several small nerves in specimen A (Plate **21**, fig. 129), while specimen B had fourteen nerves anteriorly, but fewer farther back. Seven of these were much larger than the others, the large and small nerves frequently alternating (Plate **21**, fig. 128).

The middle chamber, bearing the stylet-basis, is almost directly continuous with the anterior chamber but is sharply separated from the posterior chamber by a deep muscular constriction and numerous large gland-cells. The hook-shaped basis projects its regularly curved convex surface freely into the lumen of the middle chamber and is provided with the usual radial musculature (Plate **21**, fig. 125–127). The stylet-region of the proboscis of specimen B was cleared and mounted entire. In this preparation the basis appears black and sharply outlined because of its opacity. Its shank measures 0.046 mm. in length and 0.0115 mm. in diameter, while the curved point of the hook is 0.034 mm. in length. In specimen A the basis was sectioned obliquely, so that it appears to be crescentic in outline. This measures 0.0345 mm. between the ends of the crescent. The basis bears a single row of about six to eight small, conical stylets on its free border (Plate **21**, fig. 126). No accessory stylet-pouches could be found.

The thin-walled posterior chamber has the usual glandular epithelium, the cells being completely filled with minute secretion-granules.

The retractor-fibers are continuous with the longitudinal musculature of the proboscis, and are intricately interwoven with the musculature of the posterior end of the sheath. At the posterior end of the proboscis the outer epithelium becomes greatly thickened into a spongy mass of cells, producing the effect of a small, bulbous swelling, with the retractor at its center.

Digestive system. The mouth, which on account of the dorsal curvature of the head lies in a terminal position, opens into a rather voluminous stomach with convoluted walls. This continues posteriorly behind the brain as the pylorus, gradually losing its characteristic, large, deeply staining gland-cells. The pylorus in both specimens has several deep folds, but these may be the result of the extreme dorsal bending of the head. The pylorus does not extend so far back of the brain as it does in many pelagic species, and there is a correspondingly short caecum. From the caecum two or three pairs of very large, deeply lobulated diverticula extend forward and bend dorsally beside the brain-lobes (Plate **20**, fig. 120; Plate **21**, fig. 129).

The intestine is provided with fourteen to eighteen pairs of large diverticula, which are not distinctly branched although many of them are divided both vertically and horizontally into numerous broad lobes (Plate **20**, fig. 120). Frequently there is a more or less regular alternation between the larger, more deeply branched diverticula and smaller ones with a more regular outline. The three or four most anterior pairs are much the largest (Plate **20**, fig. 120). Several rudimentary diverticula occur near the rectum; the latter opens terminally. The intestinal epithelium, and to a lesser degree that of the diverticula, contains two distinct types of cells, namely, large, clear, vacuolated cells and relatively few smaller, denser cells crowded with deep yellow secretion-globules.

Vascular system. The deviations of this system from that of other pelagic forms constitute the most striking peculiarities of the Armaueriidae. This species agrees with *Armaueria rubra* in having a well-developed dorsal vessel which extends from the ventral cephalic anastomosis to the dorsal anastomosis at the posterior end of the body without entering the rhynchocoel. In both species the dorsal cephalic anastomosis is wanting, but in *Proarmaueria pellucida* the ventral anastomosis forms a very large lacuna which presses close against the posterior borders of the brain-lobes (Plate **20**, fig. 121).

In both specimens this lacuna is provided with several irregular diverticula, but none of the branches extend anterior to the brain. This absence of the dorsal cephalic anastomosis is doubtless correlated with the extreme anterior position of the brain. The anterior ends of the lateral vessels were distended and thin-walled in both specimens, due to the contraction of the body.

The dorsal vessel follows beneath the proboscis-sheath from its origin to the end of the latter, posterior to which it continues in the narrow mass of parenchyma which lies in the median line between the dorsal lobes of the intestinal diverticula. In the caudal region of both specimens the dorsal vessel enlarges into a broad lacuna from which a thin-walled vessel connects with each of the lateral vessels (Plate **20**, fig. 121). This dorsal lacuna also sends a conspicuous caudal vessel posteriorly to the extremity of the body (Plate **20**, fig. 121; Plate **22**, fig. 134, 135). A similar vessel is described by Brinkmann ('17a) for one specimen of *Armaueria rubra*. It should be noted in this connection that the specimens of *Proarmaueria pellucida* had been preserved in such a state of contraction that all the vessels at both ends of the body were distended with fluid and enlarged into thin-walled lacunae. It is therefore not improbable that the caudal vessel was thereby rendered much more conspicuous than would have been the case in a different state of contraction of the body.

Nervous system. The dorsal curvature of the head brings the brain to an angle of about thirty degrees to that which it would have occupied if the bending had not occurred. This seems to be a peculiarity of the Armaueriidae, for Brinkmann ('17a) found it in all the specimens of *Armaueria rubra.* In the sections cut transversely to the body-axis the brain and anterior portions of the lateral nerves are cut obliquely and nearly longitudinally (Plate **21**, fig. 129). The brain also lies very near the proboscis-pore, leaving but little parenchyma in the dorsal half of the head. Both dorsal and ventral brain-lobes are well-developed, and the nerve-cords have a distinctly double fibrous core.

The dorsal core is rounded and is frequently pressed into the dorsal part of the ventral core. It is separated from the larger ventral core by a rather thin layer of ganglion-cells. The dorsal core is more delicate and stains much less deeply than the ventral, and in most sections has no ganglion-cells dorsally, while the ventral core has a double layer of ganglion-cells on its ventral surface.

Near the brain the dorsal core is about half the diameter of the ventral core, but in the posterior half of the body it becomes gradually smaller, the separating ganglion-cells eventually disappear and the two cores merge into a single bundle before entering the posterior commissure. The delicate dorsal fibers can be distinguished from those of the ventral core by which they are nearly surrounded even after the disappearance of the separating ganglion-cells (Plate **21**, fig. 131, 132).

The dorsal nerve is small and dorsolaterals could not be distinguished at all.

The posterior dorsal commissure is situated some distance anterior to the end of the caudal fin and in close contact with the anastomosis of the three blood-vessels. At its posterior end each of the lateral nerves becomes surrounded by a thick sheath of ganglion-cells and divides into two branches. One of these is much larger than the other and bends dorsally above the rectum to form the commissure. The smaller, ventral branch continues posteriorly on the lateral border of the rectum as a distinct caudal nerve to supply the posterior parts of the caudal fin (Plate **22**, fig. 134, 135).

Except at their posterior ends the lateral nerves lie very near the lateral margins of the body.

Reproductive organs. Both the known specimens of this species exhibited a condition of the reproductive organs hitherto quite unknown among the pelagic nemerteans. Both specimens appeared to be males, with groups of large spermaries occupying the lateral margins of the head and extending posteriorly about one third the length of the body (Plate **20**, fig. 120, 121). In one of the specimens (B) a single large gonad with all appearances of an ovary occurred somewhat posterior to the middle of the body. When sectioned this gonad was found to contain not only a number of half-grown ova but also many typical cytophores of spermatocytes (Plate **23**, fig. 139, 140). In A there were several small gonads on each side showing this hermaphroditic condition, and a single ovum occurred in some of the others (Plate **22**, fig. 136–138; Plate **23**, fig. 141–143). When first seen it was thought that these ova might be unicellular parasites, but careful examination showed that in each case the cell was attached by broad pseudopodia to a layer of typical vitellogenous peripheral protoplasm exactly as in the ovaries of other species. This is sufficient proof that the cells are essentially ova and that the gonads in which they occur must be considered as hermaphroditic glands or ovo-testes. They are described more in detail, p. 191.

Spermaries. In each specimen there were about six to eight large, irregularly lobed spermaries on each side of the anterior third of the body, with about an equal number of smaller ones. They are closely crowded together into two or more incompletely separated rows and irregularly grouped in the head but are more widely separated posteriorly (Plate **20**, fig. 120, 121). Some of them were many times as large as others, but in all of those in either worm the sexual products were in about the same stage of development.

Each of the gonads is flask-shaped or retort-shaped, except as distorted by mutual pressure, with the body filled with cytophores of spermatocytes, but ripe spermatozoa were present in only one of the specimens. The narrowed end of the gonad leads as a slender sperm-duct to the ventrolateral margin of the head (Plate **21**, fig. 129). These ducts are spaced very irregularly, sometimes two or three opening close together, with others widely scattered. One spermary had become displaced during development and lay near the center of the body and close beside the pylorus. Although it had no efferent duct, its contents were in the same stage of development as the others.

The larger spermaries are provided with a thin wall composed mainly of connective tissue but surface-views show the presence of a few delicate muscular fibers. It is not improbable that in a later stage, as the spermatozoa ripen, these muscles may become somewhat more fully developed. Brinkmann ('17a) found no muscles in the young spermary of *Armaueria rubra.*

In specimen B the larger spermaries contained in addition to the spermatocytes numerous cytophores with cells undergoing the later processes of spermatogenesis and a few bundles of ripe spermatozoa. The transformations of the germinal cells are similar to those described elsewhere in this report *for Planonemertes lobata.* Figures 123, 124, Plate **20**, show the development of the cytophores and their arrangement in the gonad.

The genital ducts were frequently crowded with spermatocytes, evidently as a result of pressure during capture (Plate **23**, fig. 141). In only a few cases were the ducts open to the surface of the body; more commonly they reached only to the inner side of the muscular layers of the body-wall. The younger ducts were lined with a flattened epithelium, but those at a later stage of maturity had a layer of more nearly cuboidal cells as evidenced by the closely placed oval nuclei.

Hermaphroditic glands. The single ovo-testis in the posterior half of the body of specimen B was nearly half a millimeter in diameter and contained fifteen rather large ova and several smaller ones in addition to numerous cytophores of spermatocytes (Plate **23**, fig. 139, 140).

The cytoplasm of the larger ova has many minute clear vacuoles, but is without distinct yolk-granules. Lining that part of the wall of the gonad adjacent to each ovum is a layer of nutritive protoplasm without separation into individual cells but containing several small nuclei and forming a peripheral vitellogenous cytoplasm. The ovum is connected with this protoplasm by broad pseudopodia, exactly as in the typical ovary (Plate **23**, fig. 139–143). The smaller ova are less distinctly demarcated from the peripheral syncytium, but are easily recognized as such by their large oval nuclei. In the nuclei of the larger ova the chromatic reticulum is frequently very sharply differentiated, indicating the excellence of the preservation. The nucleolus is very large, usually pressed against the distal end of the nucleus, and often flattened to a hemisphere.

The larger ova are from 0.045 to 0.07 mm. in diameter, their nuclei measure from 0.023 to 0.03 mm., and the nucleoli 0.013 to 0.0155 mm.

Only on those parts of the wall of the gonad where the ova are attached is the peripheral cytoplasmic syncytium present, elsewhere there is only a thin membrane of connective tissue as in the typical spermary (Plate **23**, fig. 139–143). The germinal cells are in the same stage of development in this hermaphroditic gonad as in the spermaries, most of the cytophores being in the spermatocyte stage and indistinguishable from those in the normal course of development. No spermatozoa, however, were present.

In specimen A several of the more posterior gonads, situated near the posterior end of the anterior third of the body, were hermaphroditic on both sides of the body. The most posterior gonad on one side, however, was a very small spermary. In some of these hermaphroditic glands only one or two ova occurred; others were preponderatingly ovarian. One gonad had four ova and but a few spermatocytes (Plate **22**, fig. 136), another had two ova and two groups of spermatocytes, while a third was very small, with a single ovum and only a half-dozen spermatogonia (Plate **22**, fig. 137).

In a single case an ovum occurred in one of the smaller cephalic gonads, but otherwise the hermaphroditic glands occupied the interdiverticular spaces in the region of the body which contains the ovaries of other pelagic forms. In one gonad an ovum had been forced into the genital duct together with many spermatocytes, evidently due to pressure during capture. In no case was the duct of an hermaphroditic gland open to the exterior of the body.

The significance of these peculiar sexual conditions is not at present clear. That the species is truly hermaphroditic and protandric may be the most reasonable suggestion, for the hermaphroditic gonads are strikingly similar to those of such protandric forms as the fresh-water Stichostemma and the terrestrial Geonemertes. But the most careful search for metameric ovaries in an early stage of development was unsuccessful. Pending further evidence it may be considered that this species is irregularly hermaphroditic and possibly protandric.

Geographical distribution. Both of the specimens above described were taken on the Northwest Pacific expedition of the ALBATROSS at Station 4800 (Lat. 49° 06′ N., Long. 153° 06′ E.) This station lies between Codfish Banks, Sea of Okhotsk, and the Kurile Islands. Collected 22 June, 1906. One large (about 1.7 m.) net and two small (36 cm.) nets were drawn horizontally at a depth of about 600 m. for twenty minutes and then hauled vertically to the surface. The depth is here about 2000 m., and the surface-temperature at that date was 37° F.

PELAGONEMERTIDAE Moseley.

Ann. mag. nat. hist., 1875, ser. 4, **16**, p. 381.

Body usually flat and broad anteriorly; posterior end often distinctly narrowed, in some genera terminating in a more broadened caudal fin; mouth and proboscis-opening separate; intestinal diverticula usually with ventral branch, in some genera separating the lateral nerves from the body-wall; nerve-cord muscle present; dorsal vessel rudimentary, ending blindly in rhynchocoel; spermaries in two groups behind, beside or anterior to brain.

The seven genera which at present comprise this widely distributed family may be distinguished by the following key:—

A. Tentacles present in both sexes when mature .... *Balaenanemertes.*
AA. Body without tentacles .... B.
  B. Body pointed at posterior end, without caudal fin .... C.
  BB. Body not pointed posteriorly; with more or less well-marked caudal fin .... D.
    C. Lateral nerve with two fibrous cores .... *Natonemertes.*
    CC. Lateral nerve with but a single fibrous core .... *Cuneonemertes.*
      D. Caudal fin very rudimentary; intestinal canal with dark brown pigment. *Parabalaenanemertes.*
      DD. Caudal fin well developed; intestinal canal without dark brown pigment .... E.
        E. Intestinal diverticula not widely separated .... *Probalaenanemertes.*
        EE. Intestinal diverticula few, separated by much parenchyma; basement-layer underlying inner, epithelium of proboscis extremely thick .... F.
          F. Spermaries in two simple rows beside the brain .... *Gelanemertes.*
          FF. Spermaries in two dense clusters anterior to brain .... *Pelagonemertes.*

CUNEONEMERTES, gen. nov.

A new form from off the coast of Peru was found to belong to the Pelagonemertidae, but it possessed such a combination of anatomical peculiarities as to require the establishment of a new genus. For this genus the name Cuneonemertes is proposed in reference to the conical shape of the body in the type species. It may be diagnosed as follows:—

Body but little flattened; narrowed anteriorly; sharply pointed posteriorly; without caudal fin; proboscis-sheath extends entire length of body, composed of two distinct muscular layers, of which the inner is longitudinal; intestinal diverticula few and much branched, but ventral lobe does not extend between nerve-cord and body-wall; dorsal vessel ends shortly after entering rhynchocoel; nerve-cord has but a single fibrous core.

This new genus appears to be more closely related to Natonemertes than to any other described form, the principal difference being in the structure of the lateral nerves. There is a single fibrous core in the former, while in Natonemertes there are two distinct cores, separated by a layer of ganglion-cells. Such a difference indicates more than specific distinction.

31. CUNEONEMERTES GRACILIS, sp. nov.

Plate **24**, fig. 144–151.

Figure 1, 32, 33, 45.

A single specimen of this new form was taken in the Pacific Ocean off the coast of Peru. It was preserved in Petrunkevitch's fixing fluid and in consequence was very greatly contracted although some of the tissues were in an excellent state of preservation for histological study. After long preservation in alcohol the dimensions of the body were reduced to a length of 4.5 mm., with a width of 1.6 mm., and a thickness of 1.5 mm. The proboscis was partially everted, extending from the head for a distance of about 2.5 mm. (Plate **24**, fig. 144; Figure 1).

The oviducts were distinctly visible on the lateral margins of the body as a single row of about twelve short papillae, but the tissues were so opaque that the outlines of the intestinal diverticula were visible only in their distal portions (Plate **24**, fig. 144).

Shape of body. The preserved specimen is elongated oval, rather sharply pointed posteriorly, broadest a short distance back of the head and more bluntly pointed anteriorly (Plate **24**, fig. 144). The body is but slightly flattened except near the tip of the tail and shows no trace of a caudal fin. A narrow horizontal keel on each lateral margin anteriorly indicates that the body may have been somewhat flatter in life.

Integument. The superficial epithelium is wanting in all parts of the body except on the anterior surface of the head. Here a thick layer of slender ciliated and glandular cells rests upon the deep corrugations of the underlying basement-layer. Interspersed among these cells were special sense-organs similar to those described for Nectonemertes (Figure 32).

Musculature. Correlated with the nearly cylindrical outline of the body, the body-walls are much more uniform in thickness than is the case with any of the other species described in this report, the musculature being but little thicker on the dorsal and ventral surfaces than along the lateral margins (Plate **24**, fig. 147; Figure 45). The thick longitudinal muscular plates so highly developed in the more flattened forms which have distinct caudal fins are not present.

Dorsoventral muscles are few and delicate except near the posterior end of the body.

Nerve-cord muscle. The lateral nerve is provided with an unusually conspicuous bundle of longitudinal muscular fibers situated beneath the neurilemma on the dorsomedian border (Plate **24**, fig. 148). The preservation of the tissues is such as to leave no doubt whatever that this muscle originates directly from the longitudinal musculature of the proboscis-sheath at the same point where a branch from a large dorsal peripheral nerve is inserted. At this point the muscular layers of the sheath are also interrupted by the entrance of the nerve which passes obliquely through both muscular layers and then branches out beneath the lining epithelium. The nerve-cord muscle can be followed almost the entire length of the body.

Proboscis-sheath. The proboscis-insertion immediately anterior to the brain is provided not only with a very thick ring of interlacing fibers, but is held in place as in most pelagic forms by thick strands of radial muscles which pass obliquely posteriorly to be inserted in the cephalic walls on both dorsal and ventral surfaces of the head.

In the brain-region the musculature of the sheath is composed almost exclusively of longitudinal fibers, but throughout the rest of the body there are two sharply distinct layers of fibers, of which the inner is longitudinal (Plate **24**, fig. 147; Figure 45).

The proboscis-sheath extends almost the entire length of the body, the retractor-muscles of the proboscis being interlaced with the muscular wall on the dorsal side of the sheath 0.6 mm. anterior to its posterior end. The muscular walls of the sheath remain of considerable thickness even posterior to the attachment of the proboscis. Near the extremity of the body, and immediately anterior to the nerve-commissure, the rhynchocoel disappears and the sheath ends in a loose mass of parenchyma and quite without contact with the body-wall.

In addition to the usual innervation at the ring of insertion of the proboscis the sheath receives at least one pair of nerves from the lateral nerve-cords. These nerves enter the sheath a short distance back of the brain, being derived from branches of one of the pairs of dorsal peripheral nerves.

The proboscis-sheath in this specimen was enormously expanded in spite of the fact that the proboscis was everted (Plate **24**, fig. 144).

Proboscis. In this specimen the proboscis was almost fully everted, the stylet-chamber being near its tip. Since the retractor-muscle was still attached to the dorsal side of the sheath near the posterior end of the body and was everted for a distance exceeding half the body-length, the total length of the proboscis is more than double that of the body. There are twelve large proboscidial nerves (Plate **24**, fig. 146) situated in the midst of the longitudinal muscular layer. The outer intermuscular plexus is extraordinarily thickened.

The armature consists of a very small curved basis bearing several rows of stylets. The exact shape of the basis was difficult to determine, it appearing almost hemispherical in the mounted section.

Digestive system. The mouth and rhynchodeal openings are well separated, the latter being exactly terminal in position, while the mouth opens ventrally.

The oesophagus is extremely rudimentary, only a very small area of the digestive canal immediately bordering the mouth having a lining of ciliated epithelium characteristic of this organ. The stomach immediately following is differentiated into two parts by a change in the character of its glandular lining. The more anterior part, reaching from the mouth to the region of the brain-commissures is provided with a lining of cells containing a coarsely granular secretion. Posterior to the commissures these glandular cells are gradually replaced by others of a more slender form and containing a secretion which stains much more intensely in hematoxylin. The entire stomach is very short, however, extending only 0.08 mm. posterior to the brain-commissures.

Instead of merging gradually into the pylorus, as in most pelagic forms, the two organs are sharply demarcated, for the stomach enters the ventral side of the anterior end of the pylorus, leaving the dorsal side of the latter as a broad blind pouch, or pyloric caecum, somewhat as in *Planktonemertes agassizii.*

The pylorus is also very short, extending posteriorly for only 0.2 mm., before it opens into the dorsal wall of the intestine.

The intestinal caecum is rudimentary, with two pairs of diverticula. The first pair of these arise from the anterior end of the caecum and extend forward to abut against the posterior borders of the brain. The members of this pair are slender, but much branched (Plate **24**, fig. 144). A second pair of much broader diverticula arise near the base of the caecum and their branches extend dorsally to meet in the median line above the proboscis-sheath. There is a short ventral lobe which presses against the median border of the lateral nerve, but does not extend laterally beneath it.

The intestinal diverticula resemble the second pair of caecal diverticula, being broad and profusely branched, with dorsal lobes meeting above the proboscis-sheath, and each having a short ventral lobe which presses close against the lateral nerve (Plate **24**, fig. 147). In no case do these lobes pass for more than a short distance lateral to the nerve-cord and seldom separate it from the body-wall. The most anterior pair of intestinal diverticula arise at the junction of intestine and caecum. These are followed by about ten pairs of broad, repeatedly branched appendages and several rudimentary diverticula anterior to the slender rectum (Plate **24**, fig. 144).

Throughout a large part of the body neither the main intestinal canal nor the diverticula show a distinct central lumen, the slender amoeboid cells on opposite sides of the cavities coming in contact to form a continuous reticulated structure which completely obliterates the lumen. It is to be noted, however, that in this specimen the proboscis-sheath was enormously distended, thereby encroaching to a great extent on the space normally occupied by the digestive system. In the posterior half of the body both the intestine and its diverticula are normally distended and in both the lumen is widely open (Plate **24**, fig. 147).

Vascular system. The two cephalic anastomoses are as in typical pelagic forms, the dorsal vessel originating from the ventral anastomosis. After entering the rhynchocoel the dorsal vessel enlarges into a thick-walled, elongated sac 0.1 mm. in length and then ends abruptly posteriorly. The lateral vessels and their posterior anastomosis show no peculiarities, the anastomosis being immediately anterior to the nerve commissure.

Nervous system. The brain is unusually large in comparison with the size of the head, leaving but a very narrow space for the parenchyma separating it from the cephalic walls. The dorsal and ventral ganglia are closely fused, with large dorsal and ventral commissures (Plate **24**, fig. 145).

The lateral nerves have but a single fibrous core, bordered dorsally and ventrally by a thick layer of ganglion-cells (Plate **24**, fig. 148). A well-developed nerve-cord muscle is present, as described above.

The cephalic nerves are also remarkably large and conspicuous, with numerous large branches supplying the cephalic musculature, integument, and sense-organs. The dorsal nerve could not be found.

The posterior commissure of the lateral nerves occurs very near the tip of the tail and immediately posterior to the anastomosis of the lateral vessels.

Peripheral nerves and proboscis-sheath nerves. The peripheral nerves are in most respects like those of other species. A short distance posterior to the brain a pair of large branches of one of the dorsal peripheral nerves enters the lateral wall of the proboscis-sheath. This relation has not been noted in other forms.

Pyloric nerves. Another peculiarity of this species is the presence of a pair of pyloric nerves. At the point where the nerve-cord muscle leaves the longitudinal musculature of the proboscis-sheath a small branch of a large dorsal peripheral nerve enters the anterior, dorsolateral border of the pylorus.

Sense-organs. In addition to the special sense-organs scattered among the epithelial cells of the integument on the anterior surface of the head (Figure 32), there is also a small number of spherical sense-organs imbedded in the parenchyma immediately beneath the cephalic wall on the dorsal side of the head. Each of these sense-organs, including both those of the integumental and those of the submuscular type, is connected with a rather large branch of a cephalic nerve (Figure 33).

Reproductive organs. The single specimen at present known was a female with nine large ovaries on one side of the body and ten on the other (Plate **24**, fig. 144). There was much variation in the degree of maturity of the gonads, several of them containing a single fully mature ovum each, while others had two or three large eggs with smaller abortive ova, and the most posterior gonad was very immature (Plate **24**, fig. 149–150). From two of the ovaries the egg had already been discharged (Plate **24**, fig. 151).

The series of stages shows that the process of ovogenesis is of a more primitive type than that described for Planktonemertes or Pelagonemertes, the young gonad being provided with a large ovarian cavity surrounded by a single layer of follicle-cells lining the inner surface of a rather dense connective tissue-wall (Plate **24**, fig. 149). The individual-cells of the follicle are indicated by their nuclei rather than by cell-walls, the whole forming a more or less continuous syncytium. Certain of the cells become primitive ova by increasing in size and beginning the elaboration of yolk. They soon project freely into the ovarian cavity, but remain connected with the follicular syncytium by amoeboid processes. Two or three of the primitive ova increase in size at the expense of the others by absorbing through their amoeboid processes most of the yolk elaborated by all. Eventually a single one, usually the most distally situated, becomes the definitive egg-cell, the others, lying against the ovarian wall near the oviduct, remaining as abortive ova (Plate **24**, fig. 150; Figure 45).

The ovary lies on the dorsal side of the lateral nerve, and the oviduct opens to the surface of the body at a point just lateral to the nerve-cord and on the ventrolateral aspect of the body (Plate **24**, fig. 144). The gonads from which the ovum has just been discharged show the remains of the follicular syncytium together with several undeveloped and abortive ova (Plate **24**, fig. 151). It is not impossible that such an ovary may become functional again after a period of recuperation. It may thus happen that a worm of this species may produce several eggs from each ovary during its breeding period. On the other hand, it is quite possible that the egg from each of the empty ovaries had been forced out of the body by the enormous change in pressure which must have resulted while the worm was being brought to the surface from its 600-meter habitat and that if the egg had been allowed to reach complete maturity it would have absorbed all the abortive ova in the gonad before being discharged from the body.

Geographical distribution. A single specimen of this new form was taken at Station 4673, during the 1904–1905 voyage of the ALBATROSS. This station (Lat. 12° 30.5′ S., Long. 77° 49.5′ W.) was near the coast of Peru where the Antarctic current brings the cold polar water northward nearly to the equator.

The depth was about 930 meters, with a bottom-temperature of 42.5° F., but the specimen was taken in a net drawn at a depth of about 600 meters for twenty minutes and then hauled to the surface.

NATONEMERTES Brinkmann.

Rept. Michael Sars, 1917, **3**, p. 17.

Body small, broad; posterior extremity pointed, but without distinct caudal fin; mouth and proboscis-opening separate; dorsal vessel ends blindly shortly after entering rhynchocoel; one pair of caecal diverticula; spermaries in two clusters immediately behind the brain.

32. NATONEMERTES ACUTOCAUDATA Brinkmann.

Rept. Michael Sars, 1917, **3**, p. 17; Bergens mus. skrift., 1917, ny raek., **3**, no. 1, p. 110, pl. 13, fig. 13–21, Figure 25.

Figure 97, 98.

The two known representatives of this species were both small and not quite sexually mature. One of them was 9 mm. long by 4 mm. wide, and the other 8.5 mm. long and 2.4 mm. wide. The body is broad and flattened, with an acute posterior end. The very different proportions of the two specimens as indicated in Figure 97, 98 is largely due to the different state of contraction.

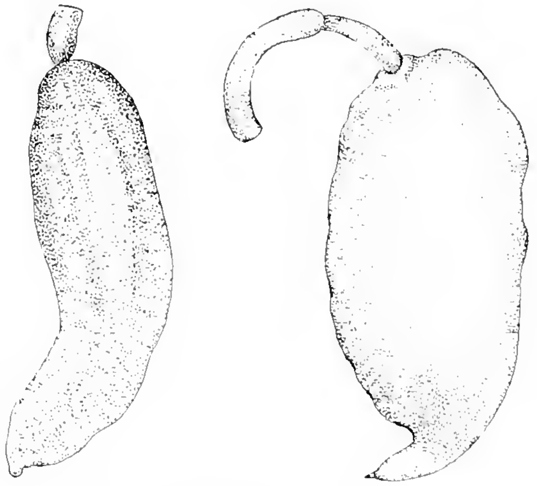

FIG. 97, 98.—*Natonemertes acutocaudata* Brinkmann. The different proportions of the two specimens is largely due to the different states of contraction. × 7. (After Brinkmann, 1917a).

Proboscis and proboscis-sheath. The proboscis-sheath extends the entire length of the body. Its wall consists of a thick inner longitudinal and an outer circular muscular layer. In connection with the proboscis-insertion originates a nerve-cord muscle which follows the median border of the nerve the entire length of the body.

The proboscis is more than twice as long as the body, and has twelve or thirteen nerves. The basis is strongly curved, with two rows of stylets.

Digestive system. There are between fifteen and twenty pairs of remarkably large, but little branched, intestinal diverticula, and one pair of caecal diverticula of similar proportions, which extend forward beside and above the brain.

Reproductive organs. Both the known specimens were males, with a compact group of four or five rounded spermaries on each side immediately back of the brain.

Geographical distribution. Northern part of the North Atlantic (Lat. 57° 41′ N., Long. 11° 48′ W.; Lat. 61° 30′ N., Long. 17° 8′ W.), from trawl lowered to a depth of about 1200 to 1400 meters.

PELAGONEMERTES Moseley.

Ann. mag. nat. hist., 1875, ser. 4, **15**, p. 165.

Body usually flat and hyaline; with much parenchyma between the organs; body-walls extremely thin, muscular layers consisting mainly of isolated bundles; mouth and rhynchodeal opening separate; intestinal diverticula few (four to twenty-five pairs); dorsal blood-vessel rudimentary; gonads of male in front of brain.

Including two species described as new in the present report, four species of this genus are known.

Key to Species.

A. With 4-6 pairs of intestinal diverticula .... B.
AA. With 12 or more pairs of intestinal diverticula .... C.
B. Body nearly as wide as long; posterior extremity bilobed; four pairs of intestinal diverticula. *P. moseleyi.*
BB. Body about one third as wide as long; posterior extremity with caudal fin; usually with six pairs of intestinal diverticula .... *P. brinkmanni.*
C. Body about half as wide as long; 4–13 pairs of ovaries; 16 proboscidial nerves. *P. rollestoni.*
CC. Body about one fourth as wide as long; 18–20 pairs of ovaries; 15 (30) proboscidial nerves. *P. joubini.*

33. PELAGONEMERTES ROLLESTONI Moseley.

Ann. & mag. nat. hist., 1875, ser. 4, **15**, p. 165; Hubrecht, Rept. Challenger. Zool., 1887, **19**, p. 25; Bürger, Monog. 22 Fauna u. flora Neapel, 1895, p. 596;

Wissen. ergebn. Valdivia, 1909, **17**, p. 183; Brinkmann, Bergens mus. aarbok, 1915, no. 1, p. 8, pl. 1, fig. 5; Bergens mus. skrift., 1917, ny raek., **3**, no. 1, p. 113, pl. 3, fig. 10.

Figure 46, 47, 99–101.

The first record of a deep-sea pelagic nemertean is Moseley's description of a single specimen of this species collected by the CHALLENGER at a station well south of Australia. Ten additional specimens were taken by the Deutsche Tiefsee expedition from four stations off the west coast of Africa and one near Ceylon. These were carefully studied and fully described anatomically by Bürger ('09, p. 183–200). Two young males were collected by the Deutsche Süd-polar expedition (1901–1913) in the Atlantic west of the Cape of Good Hope. These were studied by Brinkmann ('15).

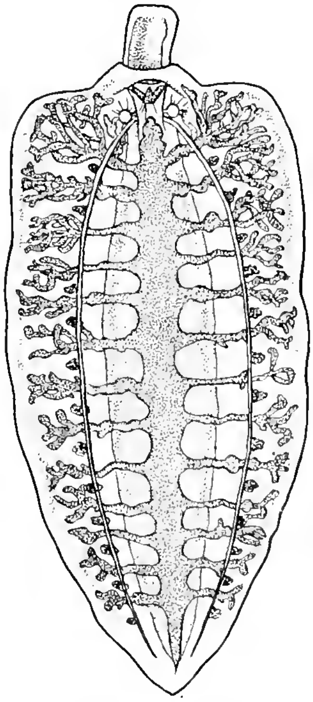

FIG. 99.— *Pelagonemertes rollestoni* Moseley. Female, with 13 pairs of small ovaries alternating with the same number of much branched intestinal diverticula. The figure shows also the outline of the proboscis-sheath, the lateral nerves and the partially everted proboscis. Length of body in life, 40 mm. (After Moseley, 1875a).

Size. Moseley's original specimen (Figure 99) was 40 mm. long, 20 mm. wide and 5 mm. thick. Those collected later were somewhat smaller but of essentially the same proportions. One specimen was 27 x 13.5 mm. The smallest specimen mentioned by Bürger was 11 mm. long and 3.5 mm. wide after preservation.

Shape of body. The body is broadly oval or irregularly egg-shaped; tapering posteriorly to a rather pointed extremity. It is broadest anteriorly or in the anterior third; with undulating lateral margins varying in outline according to the state of contraction (Figure 46, 47, 99).

Color. The color is typical of a pelagic organism, being transparent to translucent, except for the alimentary canal, which varies from yellow to shades of red and burnt sienna. The proboscis, gonads, brain, and nerve-cords are opaque, and clearly shown through the translucent body-tissues.

Alimentary canal. The median intestinal canal is narrow, with from twelve to more than twenty pairs of diverticula. The latter are much branched or lobed distally and extend well into the lateral margins of the body (Figure 46, 47, 99). The anterior pair of intestinal diverticula is largest, extending forward into the brain-region;

the posterior pairs are small and simply forked or lobed once or twice distally. Moseley's specimen (Figure 99) was larger than those figured by Bürger (Figure 46, 47) and the intestinal diverticula were indicated as more distinctly branched.

Proboscis-sheath. The rhynchodeal opening is subterminal and separate from mouth. The proboscis-insertion is firmly anchored in the cephalic tissues by four strong muscular bands, of which two are inserted in the cephalic walls dorsally and two ventrally. The rhynchocoel is voluminous, extending backward nearly to posterior extremity of body. The musculature of the proboscis-sheath consists of outer circular and inner longitudinal layers anteriorly, while farther back the fibers of the two layers become interlaced. The dorsal wall is much thicker than the ventral in the middle portions of the body.

Proboscis. This organ is very large as compared with the size of the body, and exceeds the entire body in length. Its armature resembles that of Drepanophorus, with a sickle-shaped basis armed with about nine minute, conical stylets (Figure 100). The basis rests on a powerful musculature connected with the muscular layers of the proboscis-wall in such a manner as to bring the basis to a position directly across the end of the extended organ, whereby it can function most effectively as a weapon of offense or defense. Imbedded in the tissues beneath the basis are six or more minute pouches, each containing a number of accessory stylets similar to those which arm the basis. In section (Figure 101) the basis is triangular in shape with its musculature attached to the broadest side and with the stylets imbedded at intervals in the opposite angle. A wreath of large gland-cells is imbedded deep in the tissues surrounding the basis (Figure 100).

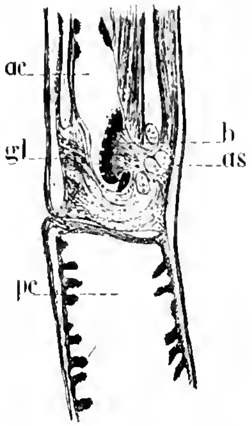

Fig. 100.— *P. rollestoni* Moseley. Longitudinal section through the middle chamber of proboscis, showing armature; *b*, basis, with 9 minute stylets; *as*, four of the six or more pouches of accessory stylets; *gl*, glandular wreath; *ac* and *pc*, anterior and posterior proboscis-chambers respectively. (After Bürger 1909).

Fig. 101.— Section of basis (*b*), showing muscular attachment (*m*), and position of stylet. (After Bürger, 1909).

Vascular system. The main lateral blood-vessels, as described by Bürger ('09), run parallel with the lateral nerves, and are united by three anastomoses, one of these being at the posterior end of the body, a second lies directly dorsal to the rhynchodeal opening, while the third is situated immediately posterior to the ventral brain-commissure. From this last anastomosis springs a small median dorsal vessel, which passes through the proboscis-sheath and continues posteriorly along the ventral surface of the rhynchocoel. This dorsal vessel ends blindly a short distance back of the brain and while still within the rhynchocoel.

Nervous system. The brain is relatively small as compared with that of littoral nemerteans of a similar size, but, on the other hand, the lateral nerves are relatively larger. The latter lie about midway between the median line and the lateral borders of the body. They unite posteriorly by a broad commissure above the posterior end of the rectum and a little more posteriorly than the anastomosis of the lateral blood-vessels. Brinkmann ('16) finds a weak muscle accompanying the nerve-cords. There are sixteen proboscidial nerves. The only sense-organs yet discovered are certain structures beneath the basement-layer which Brinkmann ('16) considers to be rudimentary ocelli.

Reproductive organs. The male is provided with a cluster of five or six egg-shaped spermaries on each side of the head directly in front of the brain (Figure 47). When distended with ripe spermatozoa the gonads of each side are crowded into a single dense mass. An efferent duct leads from the ventral end of each spermary to a separate opening on the anterior border of the head. The genital pores thus form two small groups situated to the right and left of the rhynchodeal opening.

The ovaries alternate with the intestinal diverticula but are usually less numerous than the latter. Moseley's figure (Figure 99) shows thirteen pairs of diverticula with a pair of ovaries immeditely posterior to each, with one exception. Bürger, on the other hand, finds a much smaller number of ovaries than intestinal diverticula. Thus in one specimen (Figure 46) there were but four ovaries on one side of the body and five on the other, although this specimen had about twenty-one pairs of diverticula. The immature gonad is provided with numerous primitive ova, of which but one, or occasionally two or three, reach maturity. The others are absorbed by the one, two or three which survive, as is described in detail for *Planktonemertes agassizii.* The oviducts open ventrally, and medial to lateral nerves.

Geographical distribution. Moseley's classic example was taken by the CHALLENGER expedition far south of Australia (Lat. 50° 1′ S., Long. 123° 4′ E.). The specimens described by Bürger ('09) came from off the west coast of Africa from the Gulf of Guinea to the Cape of Good Hope (Lat. 0° 20.2′ N., Long. 6° 45′ W.; Lat. 11° 28′ S., Long. 10° 24′ E.; Lat. 16° 24.9′ S., Long. 11° 8.9 E.; Lat. 31° 21.1′ S., Long. 9° 45.9′ E.) and from the Indian Ocean near Ceylon (Lat. 4° 56′ N., Long. 78° 15.3′ E.). One of these specimens is of special interest in that it was taken in a closing net at a depth of 950–700 meters, proving that the species is truly bathypelagic. The others were taken either in the vertical net or trawl at stations where the depth was from 2000 to 3500 meters. The specimens studied by Brinkmann ('16) were collected west of the Cape of Good Hope (Lat. 35° 10′ S., 2° 33′ E.) in a vertical haul from 3000 meters to the surface. The known range of this species is, therefore, from the equatorial Atlantic off the west coast of Africa to the northern Indian Ocean and to the far southeastern Indian Ocean — a range covering about 55 degrees of latitude and 130 degrees of longitude. The vast difference in surface-temperatures between these far distant regions doubtless has little influence on the natural habitat of these worms, living as they do so far beneath the surface.

34. PELAGONEMERTES JOUBINI, sp. nov.

Plate **4**, fig. 32; Plate **25**, fig. 152–161.

Figure 6.

But a single specimen of this species has thus far been secured. This specimen measured after preservation about 20 mm. in length and 5 mm. in width. The proboscis was extruded as in normal eversion (Plate **25**, fig. 153), the everted organ being just about equal to the body in length. The stylet-chamber was about one mm. from the tip. The mouth and proboscis-openings are fairly well separated.

The body is elongated oval, much flattened, broadly rounded in front and narrowed posteriorly. The posterior extremity is much flattened, but is without a well-demarcated caudal fin. In spite of the fact that the proboscis is everted, the proboscis-sheath is still greatly distended (Plate **25**, fig. 153), and reaches nearly to the posterior end of the body.

Color. No information is available regarding the color in life. After preservation the body remains somewhat hyaline, but less so than in *P. brinkmanni.* After clearing in cedar-oil the outlines of the internal organs imbedded in the translucent body-parenchyma are clearly distinguishable.

Body walls. As in other species of the genus the body-walls are very weak and in this specimen are ruptured in several places. The epithelium is well preserved on the anterior portion of the body, particularly in a broad band on both dorsal and ventral surfaces. Where present, it exhibits the typical arrangement of ciliated and glandular cells. The former are, however, relatively few, and the latter consist of two types of cells readily distinguished by the character of their secretions. The gland-cells of one type are distended with a coarsely granular, deeply staining secretion, while those of the other type are filled with a clear, mucus-like secretion. In the ciliated cells the nuclei are near the distal end, while the nuclei of the gland-cells of both types lie near the base (Plate **25**, fig. 156, 160).

The basement-layer is relatively thin.

The circular muscular layer is extremely thin and is much convoluted, due in part, at least, to the fact that the body had suffered great shrinkage during preservation.

The longitudinal muscular layer is represented by two broad bands of longitudinal fibers, one on the dorsal wall and the other on the ventral side of the body, leaving the lateral portions of the body-walls held in place only by the thin circular muscles and an occasional longitudinal or oblique fiber. The longitudinal bands are themselves broken up into bundles separated by spaces filled with parenchyma. In some portions of the wall these intermuscular spaces are fully as wide as the muscular bundle, but in most places the bundles are more nearly in contact. This condition doubtless depends upon the state of contraction of the parts involved (Plate **25**, fig. 155, 156).

The dorsoventral musculature is likewise but poorly developed. The cephalic musculature presents an interesting deviation from that in the other known species of the genus. The lateral walls of the head are without muscles other than the thin circular layer and a few scattered longitudinal fibers, and this is also the case with the ventral wall anterior to the mouth and beneath the stomach back as far as the posterior border of the brain, as well as for a narrow band in the median dorsal line in front of the brain. The longitudinal muscles are arranged in fairly well-separated bundles which form two broad horizontal sheets on the dorsal side of the head, and two similar sheets on the ventral side, one on each side of the mouth, oesophagus, and stomach (Plate **25**, fig. 156).

These four bands of muscles are well separated from the circular muscles of the cephalic wall by an irregular layer of parenchyma continuous between the muscle-bundles with that filling the interior of the head. Anteriorly these muscular bands fuse with the muscles of the proboscis-sheath at the point of attachment of the proboscis. Posteriorly they become interlaced with the longitudinal musculature of the body-walls adjacent. These muscles are evidently homologous with the more numerous muscular bundles described fully for the rhynchodeal attachment in *P. brinkmanni*.

Proboscis-sheath. Although the proboscis is everted, the proboscis-sheath remains remarkably voluminous (Plate **25**, fig. 153), due to the fact that the sheath was ruptured anteriorly and the cavity normally occupied by the proboscis was filled by the surrounding sea-water or by the preserving fluid.

The sheath extends nearly to the posterior end of the body. Its muscular walls are of far greater thickness than are the body-walls, and are composed of an inner layer of longitudinal fibers, outside which are two incompletely separated layers of about equal thickness composed of oblique or spiral fibers which run at considerable angles to each other (Plate **25**, fig. 154, 155).

In the head the layers are almost reversed, there being an inner circular layer and an outer layer of longitudinal bundles. The brain and the ventral commissure lie external to these muscles but the dorsal commissure crosses between the circular and the longitudinal layers.

The flattened endothelial lining of the rhynchocoel is in this specimen separated either by pressure or shrinkage from the muscular wall.

In this specimen the head is so greatly contracted by the eversion of the proboscis that the rhynchodeum has almost entirely disappeared, the proboscis being attached to the musculature of the proboscis-sheath almost at the rhynchodeal opening on the anterior tip of the head.

Proboscis. The fully everted proboscis extends beyond the head for a distance about equal to the length of the body. Since the posterior attachment is near the posterior end of the rhynchocoel, it follows that the anterior proboscis-chamber is equal to the body in length, while the narrow posterior chamber is twice as long.

In this specimen the small middle chamber was about a millimeter from the end of the everted organ. The armature consists of a rather broad, slightly curved basis, the anterior, free border of which is provided with about eight stylets (Plate **25**, fig. 157, 158). Each stylet consists of a discoid base and blunt, conical tooth. In some cases the tooth has been dislodged, leaving only the basal disk. The latter is somewhat crescentic in optical section (Plate **25**, fig. 159). Accessory stylets, although presumably present in life, could not be found.

The musculature of the basis and the accessory glands are very much as described for *P. brinkmanni*.

The long anterior chamber of the everted proboscis is covered externally by a thick basement-layer from which the epithelial layer (which in the normal position of the organ lines the central cavity) is almost entirely dislodged. The underlying circular muscular layer is massive, but the external circular layer (internal in the everted condition) is very thin. Lining the central cavity is a layer of epithelial cells so closely crowded together that they assume columnar form (Plate **4**, fig. 32). This layer of columnar cells represents the thin outer epithelium covering the proboscis in its normal position. The eversion of the organ so greatly decreases the area covered by these cells that their shape is changed from flattened to columnar.

The massive longitudinal muscular layer of the anterior chamber is completely divided by the nerve-ring into two unequal parts, the outer (here internal) being somewhat the thinner of the two. In the nerve-cylinder there are fifteen large nerves alternating with an equal number of somewhat smaller ones, making a total of thirty proboscidial nerves. The entire number can be seen entering the proboscis at its anterior attachment. All are connected by a loose nervous plexus. The larger nerves are somewhat triangular in shape, each with a branch extending inward to the circular muscles and thereby dividing the outer (here the inner) longitudinal muscular layer into fifteen rectangular bundles. Similar branches divide the other portion of the longitudinal musculature into less well-marked bundles. The smaller nerves are nearly circular in section, and these are surrounded more closely by the muscles (Plate **4**, fig. 32).

The posterior chamber is naturally very slender when the proboscis is fully everted as in this specimen. The muscular layers are very distinctly separated into a thin, outer, circular, and a somewhat stronger inner, longitudinal layer. The internal lining of columnar cells, distended with their granular secretions, is well preserved.

Alimentary canal. The mouth with its much folded epithelial lining is on the ventral side of the tip of the head, and quite distinctly separated from the proboscis-opening. The mouth leads without change of epithelial lining into the very short oesophagus, and the latter passes imperceptibly into the stomach somewhat anterior to the brain (Plate **25**, fig. 156). Behind the brain the pylorus, with a beautifully ciliated epithelium containing relatively few gland-cells, leads back for a distance about equal to the diameter of the head and then enters the intestine. From this point the intestinal caecum extends forward about half-way to the brain as a rather narrow tube entirely without branches. The first pair of diverticula therefore originate from the anterior end of the intestine proper.

There are eighteen intestinal diverticula on each side, but these are not exactly paired (Plate **25**, fig. 153). The most anterior diverticulum on each side is much larger than any of the others. It is much lobed and extends forward as far as the brain-region. The remaining diverticula are relatively simple with only a few lobes and without trace of ventral branch (Plate **25**, fig. 155). There is a gradual decrease in size and branching posteriorly until the condition of mere lobes is reached just anterior to the rectum (Plate **25**, fig. 153).

Blood vascular system. The lateral blood-vessels and their transverse connections are essentially as described for *P. rollestoni* and *P. brinkmanni*. The minute median dorsal vessel enters the rhynchocoel just behind the brain, but after extending posteriorly a short distance swells out into a broad, flattened sac which ends blindly at a point near the anterior end of the intestinal caecum.

Nervous system. The brain is of moderate size, with a complete fusion of dorsal and neutral ganglia. Both of the ganglia extend back into the lateral nerves. In this specimen the commissures are greatly lengthened, due to the unusual state of distension of the proboscis-sheath in this region (Plate **25**, fig. 156). The cephalic nerves, as well as the branches leaving the lateral nerves, are very conspicuous as they pass through the parenchyma.

Several of the cephalic nerves were observed to fuse directly with the muscular bundles which they innervate. In such cases the nerve enters the muscular bundle and spreads out in direct contact with the fibrils.

Reproductive organs. The only specimen available for study was a female with eighteen immature ovaries on one side and twenty on the other. As there were eighteen pairs of intestinal diverticula the ovaries retain with unusual regularity their primitive interdiverticular position. They lie just medial to the lateral nerves (Plate **25**, fig. 153).

Each gonad contains about twenty primitive ova, of which from three to six are much larger than the others. These latter lie on the dorsal side of the ovary. Next them are several of smaller size, while the ventral side of the ovary has about a dozen still smaller abortive and undeveloped ova (Plate **25**, fig. 152).

The larger ova have irregular, lobular surfaces bordering a small, central ovarian cavity, and are connected peripherally by protoplasmic processes with the syncytial mass containing the smaller ova. Presumably one, two, or three of the largest ova eventually mature, all the others degenerating, as described for *P. brinkmanni*.

The oviducts were not formed, but a group of closely placed columnar cells on the ventral wall of the gonad indicates the rudiment from which the oviduct later develops.

Geographical distribution. The single known specimen of this species was collected by the U. S. Fish Commission Steamer ALBATROSS in the equatorial

Pacific (Station 4719; Lat. 6° 30′ S., Long. 101° 17′ W.). The depth at this locality is 2285 fms., but this specimen was taken in a net drawn at 300 fms. and while still open raised to the surface.

The species is named in honor of Professor Louis Joubin of the Museum d'Histoire Naturelle de Paris, a zoölogist well-known for his investigations on marine animals and author of important papers on both pelagic and littoral nemerteans.

35. Pelagonemertes moseleyi Bürger.

Monog. 22 Fauna u. flora Neapel, 1895, p. 596; Hubrecht Rept. Challenger. Zool., 1887, **19**, p. 25 (in part); Brinkmann, Bergens mus. skrift., 1917, ny raek., **3**, no. 1, p. 116.

Pelagonemertes rollestoni Moseley, Ann. mag. nat. hist., 1875, ser. 4, **15**, p. 377 (young).

Figure 102.

Only one specimen of this remarkable nemertean is known. This was carefully studied while living, but was destroyed in an attempt to preserve it.

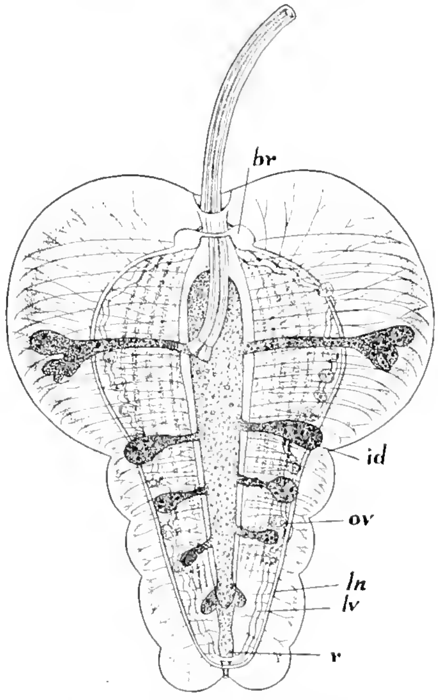

Fig. 102.—*Pelagonemertes moseleyi* Bürger. Mature female with partially everted proboscis, showing the internal organization as seen through the translucent, gelatinous body-tissues; *br*, brain; *ln*, lateral nerve; *lv*, lateral blood-vessel; *r*, rectum; *id*, intestinal diverticulum; *ov*, ovary. (After Moseley, 1875a).

As shown in Figure 102 the body is very broad and flat with lobed anterior, lateral, and posterior margins. The specimen measured 13 mm. in length by 11 mm. in width, with a thickness of only 1 mm. The tissues are so perfectly transparent that the entire internal structure can be seen without difficulty.

Internal organization. Figure 102 illustrates so well the essential features of the principal organ-systems that the mention of only a few details is necessary. The intestinal cells were filled with a reddish brown matter, consisting of large granules and oil-globules, and the substance of the five pairs of diverticula was darker, with yellow and red globules.

The body-musculature is but poorly developed, the texture of the body being almost gelatinous. The longitudinal muscles are shown as narrow isolated bands in the median portion of the body where they are best developed.

The ovaries are situated medial to the lateral nerves. Posteriorly these gonads alternate with the intestinal diverticula, but more anteriorly there are four pairs of ovaries between the first and second pairs of diverticula. There are in all seven ovaries on one side of the body and eight on the other. The oviducts were fully formed, and are described as opening dorsally. This description, however, may be assumed to be erroneous, since in all pelagic forms known at present the openings of the oviducts are situated ventrally.

This specimen was collected by the CHALLENGER expedition in Lat. 34° 58′ N., Long. 139° 3′ E. This station was off the southern coast of Japan, where the water has a depth of 420–755 meters.

36. PELAGONEMERTES BRINKMANNI, sp. nov.

Plate **2**, fig. 9–15; Plate **3**, fig. 16, 17; Plate **4**, fig. 29–31; Plate **26**, fig. 162–166; Plate **27**, fig. 167–173; Plate **28**, fig. 174–177; Plate **29**, fig. 179–188.

Figure 1, 14, 22, 44, 103, 104.

The collections of the Northwest Pacific expedition with the U. S. F. C. S. ALBATROSS in 1906 included twenty-three specimens of a new species of Pelagonemertes closely related to *P. moseleyi* Bürger. These were all preserved in formalin and were in such excellent condition that the gelatinous tissues of the body still retained their natural hyaline condition, allowing many of the features of the internal organization to be studied without further treatment.

The natural colors, too, seem to have been well preserved, for the general appearance of the body and its organ-systems agrees well with the description given by Moseley for the living individual of *P. moseleyi* which he had for study.

Careful comparison of Moseley's description ('75a) and the beautiful figure of *P. moseleyi* proves the distinctness of the two species, and I take pleasure in naming the present species in honor of Dr. August Brinkmann, the zealous Norwegian investigator of the bathypelagic nemerteans.

A tabular comparison will indicate the principal measurable distinctions between these species, and also between these and two of the other species of the genus.

	P. rollestoni	*P. moseleyi*	*P. brinkmanni*	*P. joubini*
Size — length	11–40 mm.	13 mm.	6–24 mm.	20 mm.
Size — width	3.5–20 mm.	11 mm.	2.5–8 mm.	5 mm.
Size — ratio	Ca. 2 : 1	Ca. 1 : 1	Ca. 3 : 1	4 : 1
Shape of body	Oval	Broad	Narrow	Narrow

	P. rollestoni	*P. moseleyi*	*P. brinkmanni*	*P. joubini*
Posterior extremity	Narrow	Bilobed	With caudal fin	Narrow
Intestinal diverticula	12–16 (25) prs.	4 prs.	4–6 (10) prs.	18 prs.
Intestinal diverticula	Branched	1 pr. bilobed	Unbranched	1 pr. branched
Stylet basis	Ca. 9 stylets	Unknown	Ca. 7 stylets	Ca. 8 stylets
Ovaries	4–13 prs.	7 prs.	6–8 prs.	18–20 prs.
Spermaries	5 (8) prs.	Unknown	5 (7) prs.	Unknown
Proboscidial nerves	16	Unknown	19	15 (30)

Although there is intergrading in several of the features indicated, doubtless a single glance at the living individual would place it in its proper species, for the shape of the body and the arrangement of the intestinal diverticula would enable one to immediately distinguish between these four species.

Three of these twenty-three specimens were cleared for permanent mounting as transparent objects and four others were cut into serial sections. One series of each sex was cut transversely and another series sagittally.

Shape and size. The body is broad and flattened, widest anteriorly, and narrowed toward posterior extremity, which then broadens out to form a horizontal caudal fin. The anterior margin is often truncated and indented in the median line, causing the mouth and proboscis-opening to lie in a broad pit. In some of the specimens the proboscis is partially everted and in others it has been entirely disrupted and lost.

The largest specimen measured 24 mm. in length and 8 mm. in width, with a thickness of about 2 mm. Other specimens measured 20 x 8 mm.; 18 x 7 mm.; 15 x 6 mm.; 15 x 5 mm.; 14 x 5 mm.; 10 x 4 mm.; 9 x 3.5 mm.; and the smallest specimen collected was 6 mm. long, 2.5 mm. wide, and less than 1 mm. thick. The everted proboscis is nearly 1 mm. in diameter and in several specimens extends beyond the anterior end of the body for a distance of 4 mm. or more. The dimensions given are doubtless considerably less than those of the living worms, for even in formalin there is a considerable shrinkage after preservation.

The body-proportions average nearly three times as long as broad, and in all the flattened caudal fin is a distinct feature. In these respects the specimens of this species are strikingly different from the single known specimen of *P. moseleyi*, for the latter was nearly as wide as long (13 x 11 mm.), with conspicuously lobed margins but without a caudal fin (Figure 102). In *P. rollestoni* also the body tapers gradually to the posterior extremity (Figure 46, 47, 99).

Color. Although the collector's labels bear no reference to the natural color in life, the specimens, preserved in formalin, leave no doubt as to the hyaline nature of the body in life. After a year's preservation the body retains as full a degree of transparency as do any of the most hyaline pelagic animals, as Salpa, Medusae and ctenophores.

In all the specimens the intestinal tract is distinct and opaque after preservation, and therefore stands out conspicuously in the hyaline body, the exact outline of both the main canal and the intestinal lobes showing with great distinctness. In some cases both canal and diverticula are opaque white in color; in others the canal is white and the diverticula pale yellow, while the remaining specimens have all parts of the intestinal canal of various shades of yellow (Plate **2**, fig. 9–15). The colors are due to the contents of the cells lining the digestive system, which, as in many other nemerteans, are filled with deeply colored granules and globules of various sizes. The relative abundance of these bodies determines the degree of coloration of the parts. One specimen after having been mounted in glycerine on a slide and frequently exposed to the light still retains this yellow coloration. The nervous system is opaque, but without distinct color. In the females the ovaries appear as whitish or pale yellowish, rounded organs along the sides of the body, and in the males are the whitish spermaries on each side of the mouth. The proboscis is opaque and without definite color, while the proboscis-sheath outlines appear as slightly opaque bands (Plate **2**, fig. 9–15).

It may be assumed that the colors in life were similar, but more intense than those retained after preservation in formalin, for the specimens of *P. rollestoni* studied by Bürger ('09) were not greatly different when alive than those of the present species after preservation.

There is still the probability that the loss of the integument which the worms suffer while being brought to the surface would make them appear somewhat different than they were when in their natural habitat.

Integument. Only in a few isolated patches is the superficial epithelium of the body retained. Elsewhere over the surface of the body, as well as in the greater portion of the anterior chamber of the proboscis this tissue has disappeared. Its loss appears to be associated with the transfer of the specimens from a considerable depth to the surface of the ocean. Such a dislodgment of the epithelium occurs in all bathypelagic forms, even in specimens which are known to have come from but a few hundred meters in depth.

In those occasional spots where the integument is retained, it shows both glandular and ciliated cells, but is vastly thinner than in littoral forms. Both rhabdites and mucus-secreting cells appear to be few in number and no frontal glands or submuscular glands occur. It may therefore safely be assumed that these worms have but little capacity for secreting mucus.

Muscular system. The body-walls in this genus are reduced to a greater extent than in any other described form, the principal muscular layers being in some regions of the body limited to single sheets of fibers in isolated groups. Nevertheless the two principal muscular layers as found in other metanemerteans, namely, outer circular and inner longitudinal layers, can be recognized in all parts of the body except on the lateral and anterior surfaces of the head (Plate **29**, fig. 179–188).

In the anterior portion of the body the basement-layer rests directly upon the internal gelatinous tissue, with only here and there an isolated circular or longitudinal muscular fiber. On both dorsal and ventral surfaces, however, both layers are complete, and the longitudinal layer is in many places the thickness of two or three muscular fibers (Plate **28**, fig. 175–176, 176a).

More posteriorly the musculature increases in thickness, particularly on dorsal and ventral surfaces. Toward the posterior end of the body and especially in the constriction of the body just in front of the caudal fin the muscular layers increase their thickness on the lateral surfaces also. They decrease again in the caudal fin except for a single broad plate of longitudinal fibers along the median lines on both dorsal and ventral surfaces. Dorsoventral muscles are abundant only in the caudal fin. This weakness of the musculature is responsible for the irregularities of the body-outline, both in breadth and thickness, as seen in many preserved specimens; and the absence of muscular walls in the front part of the head accounts for the easy rupture of the basement-layer whereby either the contraction of the body or the change in pressure in bringing the worms to the surface of the ocean forces the spermaries outside the head (Plate **26**, fig. 165).

Such an extremely reduced muscular system indicates very limited powers of locomotion, and we may conceive of these animals floating quietly or swimming sluggishly, far beneath the surface of the ocean, by means of dorsoventral movements of the caudal fin.

Other parts of the muscular system are in essential agreement with the descriptions given by Bürger ('09) for *P. rollestoni.* The musculature of the spermaries is of particular interest because it has been found only in the pelagic nemerteans. This remarkable muscular apparatus consists of a layer of spiral muscle-fibers which completely surrounds the spermaries and extends a minute distance along the wall of the sperm-ducts. The contraction of these muscles presumably aids the poorly developed muscles of the body-walls in the head-region in expelling the spermatozoa at the appropriate time. This musculature is most highly developed as in *Nectonemertes mirabilis*, described elsewhere in this report.

Nerve-cord muscles. In this species, a few longitudinal muscular fibers lie in the neurilemma on the medial border of the lateral nerves. The origin of this muscle as a slender strand of wavy fibers from the musculature of the proboscis-sheath a short distance back of the brain is shown (Plate **27**, fig. 173).

Stomach-muscles. The stomach appears to receive muscle-fibers from two sources in this species. Originating from the dense musculature at the ring of insertion of the proboscis a pair of broad, but very thin bands of muscles pass posteriorly immediately beneath the ventral brain-lobes to become inserted in the dorsal wall of the posterior end of the stomach. In addition to these, a few fibers from each member of the median ventral pair of proboscis attachment-muscles enter the lateral walls of the stomach as they pass toward their main insertion in the ventrolateral wall of the body.

Dorsoventral musculature. Only a few dorsoventral fibers are to be found anterior to the caudal fin. Of these, an occasional fiber is inserted in the wall of the proboscis-sheath. Such a union between the dorsoventral muscles and the wall of the proboscis-sheath has been described for other forms and is particularly well shown in the anterior part of the body of Planonemertes, as described (p. 144, 145) and shown on Plate **14**, fig. 96.

Proboscis-sheath. In the preserved specimens the head is broad and somewhat bilobed anteriorly, with a median vertical groove which is deepest on the ventral side. Into this groove the rhynchodeum opens ventrally, with the mouth immediately posterior to it. When the proboscis is partially everted (Plate **26**, fig. 163), and presumably also in life when not strongly contracted, the groove disappears and the head is narrowed and bluntly pointed anteriorly. This is in agreement with observations of living individuals of *P. rollestoni*.

The rhynchodeum is short, extending only about three fourths the distance from the anterior margin to the anterior border of the brain. It is a narrow tube with the usual lining of ciliated epithelium, and is without muscles except for a few circular fibers near its posterior end, and these extend forward from the ring of attachment of the proboscis.

The region where the proboscis is inserted, however, that is, the ring of muscles separating the rhynchodeum from the rhynchocoel, is anchored firmly in place by a number of large muscles connected with the cephalic walls. These proboscis attachment-muscles extend radially outward from the ring of insertion, pass through the gelatinous tissue and become interwoven with the musculature on both dorsal and ventral surfaces of the head. There are five pairs of these muscles, of which two pairs are attached to the ventrolateral surfaces of the head at different levels, while the three other pairs are interlaced with the dorsal cephalic walls (Figure 14).

One of the two ventral pairs passes close beside the anterior border of the stomach and extends to the ventral surface of the head near the median line (Plate **27**, fig. 172, 173; Plate **29**, fig. 179–181; Figure 14) and may be called the median ventral attachment-muscles. The second of the ventral pairs extends to the ventrolateral aspects of the head in the brain-region and has a similar interlacing with the musculature of the cephalic wall.

Of the three pairs of muscles passing from the insertion-ring to the dorsal side of the head, the largest is the median dorsal pair of muscles, and these are fastened to the dorsal wall near the median line; the two other pairs being attached on the dorsolateral aspects of the head, one somewhat more anteriorly than the other.

When the proboscis is in its normal position these proboscis attachment-muscles pass to the cephalic walls somewhat anterior to the brain (Plate **29**, fig. 179–181; Figure 14), but when the proboscis is everted the brain is drawn forward to such an extent that the latter comes to lie somewhat anterior to the position where the more posterior attachment-muscles reach the cephalic walls (Plate **27**, fig. 172, 173).

The longitudinal muscles both of the proboscis and of the proboscis-sheath enter the insertion ring together and both these layers are directly continuous with the attachment-muscle bundles, the fibers of all these muscles being intimately interwoven in the insertion-ring (Figure 14).

The proboscis attachment-muscles thus furnish a firm anchorage for the proboscis-insertion in its proper position in the midst of the gelatinous tissues of the head. They thereby supplement the extremely weak musculature of the cephalic walls and prevent a rupture of the tissues when the proboscis is everted.

The proboscis is very large, and its sheath correspondingly developed. The latter extends through about nine tenths of the entire length of the body (Plate **26**, fig. 162, 163). Near its posterior end it contracts rather abruptly into a narrow tube which ends blindly in the midst of the surrounding gelatinous tissue between intestine and dorsal body-wall.

The musculature of the proboscis-sheath is remarkably strong as compared with that of the body-walls, and consists of two distinct layers, outer, circular and inner longitudinal, as in many other forms. In moderate states of contraction each muscular layer of the sheath is about twice as thick as the corresponding layer of the body-wall. Both longitudinal and circular layers are of about equal thickness, and retain their individuality until near the posterior end of the sheath (Plate **29**, fig. 183).

Proboscis. The retractor-muscle of the proboscis is attached to the dorsal wall of the sheath at a point about two thirds the distance from anterior to posterior end of body. The attachment is remarkably firm, and is accomplished by the muscular layers of proboscis and sheath being intimately interwoven. The proboscis thus ends bluntly and without the long rectractor-fibers found in many other species. The proboscis is remarkably large for the size of the body, and greatly exceeds the body in length, and is therefore much convoluted in its normal position. It is attached anteriorly a short distance in front of the brain, its ring of attachment being firmly anchored in place by strong muscular bands which extend radially through the gelatinous tissue of the head and fasten at numerous points into the musculature of the cephalic walls (Plate **27**, fig. 172, 173). The arrangement of these muscles is explained above in the description of the rhynchodeum.

The proboscis shows the usual three communicating chambers (anterior, middle, and posterior), but the middle chamber is less well demarcated than in other metanemerteans, as Bürger ('09) has well described for *P. rollestoni*. The anterior chamber has extremely thick walls and constitutes the larger portion of the organ (Plate **4**, fig. 29, 30; Plate **27**, fig. 169). The flattened epithelium covering the proboscis externally is well preserved (Plate **4**, fig. 30), but in all the specimens studied the entire epithelial layer which in life lines the lumen of the anterior chamber had been dislodged except near the posterior end. This leaves the very thick basement-layer of gelatinous tissue with its much-folded surface freely exposed (Plate **4**, fig. 29, 30). As in the case of the epithelial covering of the body, the change in pressure while bringing the worm from the ocean-depths to the surface presumably causes the dislodgment of the epithelium on the exposed surfaces. Yet it is only in those parts, including both the integument and anterior proboscis-chamber, where the epithelium rests on a thick gelatinous basement-layer, that the epithelial cells have been dislodged. Where the gelatinous layer of the proboscis becomes thin, as in the posterior end of the anterior chamber, in the posterior chamber, and likewise in most of the rhynchodeum, the epithelium is well preserved. In all bathypelagic forms the loss of epithelium is associated with a thick gelatinous basement-layer.

In the greater portion of the wall of the anterior chamber the gelatinous layer is fully twice as thick as the combined muscular layers (Plate **4**, fig. 30), but toward the posterior end of this chamber it almost disappears and is found only as a delicate basement-layer in middle and posterior chambers.

Where the epithelial lining has been retained it shows essentially the same arrangement of slender columnar cells as in littoral forms.

The outer, flattened epithelium rests upon a delicate basement-layer, beneath which is the thin layer of outer circular muscles. Beneath these is the massive longitudinal muscular layer with the usual division into outer and inner portions separated by the nerve-plexus. Internal to the longitudinal muscles is the inner circular muscular layer, which is very thin anteriorly but massively developed near the posterior end of the anterior chamber.

A slight constriction separates the anterior from the middle chamber, due to the extensive development of the inner circular muscles and the elimination of the layer of gelatinous tissue (Plate **27**, fig. 167, 168).

In the anterior part of the middle chamber the lumen enlarges again and is lined with closely packed slender columnar cells similar to those of the anterior chamber. A little farther back in the middle chamber (Plate **4**, fig. 31), the muscular layers become confused, the fibers in great measure becoming interlaced and assuming a radial or oblique direction. They eventually converge from all sides to form a powerful musculature for the stylet-basis.

As shown in Plate **27**, fig. 167, 170, the basis is sickle-shaped or crescentic, with a slight constriction dividing the more slender portion, which projects into the lumen of the proboscis, from the more massive basal portion which is imbedded in the muscles of the proboscis-wall. The powerful muscles which control the movements of the basis are attached along its concave border, those of the anterior portion radiating from a single large bundle.

The convex side of the basis, which projects freely into the lumen of the central chamber, is armed with a number of very minute, conical stylets along its free border. The exact number of these stylets seems to be somewhat variable, but there are at least seven. There are also from about nine to twelve pouches, each containing several accessory stylets similar to those on the basis. The number of accessory stylets in each pouch varies from two to seven (Plate **27**, fig. 167, 168). Opening into the lumen near the basis is a crescentic group of large gland-cells with deeply staining secretions (Plate **27**, fig. 169).

Bürger ('09) found in *P. rollestoni* a sickle-shaped basis with nine or more small, conical stylets, accompanied by numerous large gland-cells and twelve or more accessory stylet-pouches, each containing up to twelve minute stylets exactly like those on basis.

The middle chamber is contracted to a narrow canal posteriorly by the encroachment of the musculature of the stylet basis. At the beginning of the posterior chamber the lumen enlarges abruptly, and its walls become relatively thin. The three muscular layers continue but are composed of but few fibers. The epithelium lining the lumen is composed of a single layer of very large, columnar gland-cells with a vacuolated cytoplasm filled with glandular secretions, the products of which are found abundantly in the lumen (Plate **28**, fig. 174).

There are nineteen proboscidial nerves in this species; they enter the proboscis at its insertion (Plate **4**, fig. 29), and retain their identity until the middle chamber is reached. Here they enter into a general anastomosis, giving this part of the proboscis a profuse innervation. This may indicate a highly sensory nature for this region as well as precision in muscular action. In the posterior chamber only a loose plexus of nerves is found.

Alimentary canal. In its general features the digestive system of this species agrees rather closely with the descriptions given for *P. rollestoni* by Moseley (1875), Hubrecht (1887), and Bürger ('09). In numerous details, however, this new species offers modifications which are of much importance in any consideration of the morphological relations of these organs in the various groups of nemerteans.

Owing to the great transparency of the tissues even in specimens preserved in formalin the general features of the digestive system are very easily distinguished. The intestine and its diverticula are opaque and conspicuously colored, in some specimens white and in others yellow (Plate **2**). In fact, as stated above, the outline of the digestive tract is often more distinctly seen after clearing in suitable medium than is the outline of the body itself, and this is doubtless true of the living animal.

The mouth is situated subterminally, beneath and a little behind the rhynchodeal opening (Plate **26**, fig. 164, 165). From the mouth a rudimentary oesophagus extends backward hardly to the anterior border of the brain, where it opens into the much larger stomach, the latter with greatly convoluted walls. The stomach is only about as long as its transverse diameter and at the posterior end of the brain-region passes into the narrow pylorus, this latter opening into the dorsal wall of the median intestinal canal a short distance from its anterior end. This leaves a small portion of intestine lying anterior to the pylorus-opening as a caecum (Plate **26**, fig. 164; Figure 104). The intestine extends in the median line to the posterior end of the body, a short portion of its posterior end being narrowed to form the rectum (Figure 44, 103). The intestine in typical examples bears four pairs of large diverticula which extend out symmetrically toward the lateral walls of the body (Plate **2**, fig. 9, 15; Figure 44). Posterior to these there are commonly two or three unpaired diverticula of smaller size, and still farther back, at about the junction of intestine and rectum, there is often a group of several small lobes, which are apparently rudimentary caeca. The number of diverticula is therefore much smaller than in *P. rollestoni*, which has from twelve to twenty-five pairs, and larger than in *P. moseleyi*, which had but four pairs in the only specimen known. In *P. rollestoni*, moreover, the diverticula are forked distally into a number of distinct lobes or branches. In *P. moseleyi* only the members of the most anterior pair are bilobed near their distal ends. Only exceptionally in *P. brinkmanni* is any one of the diverticula bilobed. One such instance is, however, shown in

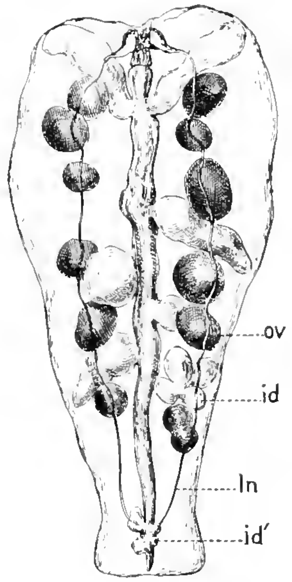

Fig. 103.—*Pelagonemertes brinkmanni* Coe. Outline of mature female from ventral surface, showing the large ovaries *ov*, each with one or two nearly ripe ova; *id*, intestinal diverticulum; *id′*, small diverticula immediately anterior to rectum; *ln*, lateral nerve.

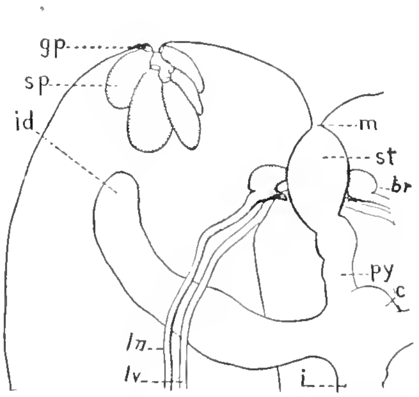

Fig. 104.—*Pelagonemertes brinkmanni* Coe. Outline of one side of head of mature male from ventral surface, showing the five flask-shaped spermaries, each opening on the summit of a low genital papilla (*gp*); *m*, mouth; *st*, stomach; *py*, pylorus, with a rudimentary caecum (*c*) at its opening into the intestine (*i*); *id*, intestinal diverticulum; *br*, brain; *ln*, lateral nerve; *lv*, lateral vessel.

Figure 44 B, but this plainly represents a medial fusion of the third and fourth appendages on one side of the body.

It is seldom that both members of any pair of these intestinal diverticula except the first leaves the median canal symmetrically. As a rule all of those of one side are slightly or considerably anterior to the members of the corresponding pairs of the other side. Thus in the specimen shown in Plate 2, fig. 9, all those on the right-hand side are anterior to their mates on the left-hand side. In Figure 44 A, the same condition holds for all except the first pair, that is, the diverticulum on the right side of the body is anterior to its mate on the left. In the figure the reverse appears to be true, but it should be noted that this drawing shows the ventral surface. In Figure 44 B, the same relation holds except for the median fusion of the third and fourth diverticula on the left side of the body. Curiously enough, it happens that in most of the specimens in this collection the diverticula on the right side of the body are anterior to their mates on the left. This may be due to a chance selection of a limited sample of the species, but it is noteworthy that in Moseley's single specimen of *P. moseleyi*, although the four pairs are nearly symmetrical, the posterior three pairs likewise all show the right diverticulum slightly anterior to left.

No two specimens in this collection, however, are exactly alike in regard to the arrangement of these intestinal diverticula. Those, of the first, most anterior, pair are largest and extend forward to the lateral borders of head in the brain-region. Plate 2, fig. 9–15, and Figure 44, 103 show some of the many modifications in the configuration of the diverticula in different specimens. In Plate 2, fig. 10 only the first pair has symmetrical members, there being only a rounded protuberance in place of one member of the second pair. Both members of the fourth pair are more or less lobulated, and the rudimentary diverticula near the posterior end of the intestine are unusually numerous. In Plate 2, fig. 11 the second and fourth pairs are very broad and the number correspondingly reduced. Only the four primary pairs are developed in the very young specimen shown in fig. 12. The small specimen shown in Plate 26, fig. 162 has more numerous diverticula than most of the specimens in this collection, there being six on the left side of the figure (right side of the body) and nine on the opposite side. Both this figure and fig. 163 show how the diverticula become swollen distally corresponding to the strong contraction of the body.

A female from Station 4767 had more numerous diverticula, there being on the left side of the body six large diverticula, followed by four of much smaller size, three of which were rudimentary. On the right side there were five large diverticula followed by three smaller and one rudimentary lobe (Plate 2, fig. 14). The total for this specimen, including the rudimentary lobes, is thus ten on one side and nine on the other.

Oesophagus. As already stated, this part of the digestive tract is represented only by a very short, and in normal states of contraction, undifferentiated tube, without convoluted walls and with few gland-cells, between the mouth and stomach. When the body is strongly contracted the oesophagus broadens and shortens to such an extent as to almost disappear. The mouth in such cases seems to open directly into the spacious stomach which is now drawn forward far in front of the brain. In one specimen sectioned, the oesophagus opens into the stomach in the exact region where the proboscis is attached to the posterior end of the rhynchodeum, but in another the oesophagus ended far anterior to this point, being merely a constriction between mouth and stomach.

Stomach. The stomach (Plate 26, fig. 164; Plate 29, fig. 181) has highly convoluted walls and is doubtless capable of great distension. Its epithelium is crowded with gland-cells filled with densely staining secretions.

Pylorus. Shortly back of the brain-region the stomach becomes gradually narrower and its convolutions disappear. Its epithelium loses the majority of its gland-cells and the tube continues posteriorly as the pylorus (Plate 26, fig. 164). The change in form may be either gradual or abrupt according to the state of contraction of the parts.

The pylorus is lined with beautifully regular columnar cells with long cilia, with interspersed glandular cells filled with a granular secretion (Plate 28, fig. 175a).

Toward its posterior end the pylorus likewise becomes gradually smaller and its epithelial lining becomes thinner and thinner. No gland-cells are found in this portion of the tube.

The pylorus opens into the dorsal wall of the intestine as in many other metanemerteans. There first appears a narrow slit in the ventral wall of the pylorus connecting this tube with the intestine. The slit gradually widens until the entire ventral wall of the pylorus disappears, giving the intestine at this point a dorsal wall of epithelium that really belongs to the pylorus. This epithelium continues backward for a short distance as a narrow band in the dorsal wall of the intestine.

Intestine. Since the pylorus opens through the dorsal wall of the median intestinal canal a short distance back of its anterior end, there is produced an intestinal caecum of the same length (Plate 26, fig. 164; Figure 104). Here again there is considerable variation, but in general the caecum is not longer than its median diameter. In this respect Pelagonemertes is in sharp contrast with Nectonemertes and many other metanemerteans, where the caecum forms such a large part of the alimentary canal. The epithelial lining of the caecum, intestine, and intestinal diverticula has the same general character as in other forms, but in all the specimens sectioned this tissue was too poorly preserved for detailed histological study.

Rectum. Posterior to the last rudimentary diverticulum the intestine narrows to a slender tube, the rectum, which opens at the base of the median indentation of the caudal fin.

Vascular system. The course of the lateral vessels from the brain-region to their dorsal union above the rectum can be followed with the greatest ease in specimens cleared in oil. There are two distinct anastomoses anteriorly; one of those being above the rhynchodeum just anterior to the attachment of the proboscis, and the other beneath the proboscis-sheath just posterior to the ventral brain-commissure (Plate **29**, fig. 179–182). A very short, dorsal, median vessel arises from the ventral anastomosis; this vessel ends blindly after passing obliquely through the ventral wall of the proboscis-sheath, as Bürger ('09) discovered in *P. rollestoni*. In *P. brinkmanni* the dorsal vessel extends within the rhynchocoel for only about .06 mm.; a distance equal only to the thickness of six of the microscopic sections. The posterior end of the vessel projects freely into the rhynchocoel, being attached to the ventral wall of the proboscis-sheath only at its point of entrance. It is, however, entirely covered by the endothelium of the rhynchocoel.

From the dorsal cephalic anastomosis there may appear a pair of lateral evaginations to form a pair of short, cephalic lacunae which extend anteriorly in either side of the rhynchodeum (Plate **29**, fig. 179; Figure 25). These lacunae are conspicuous only when the tissues of the head are contracted in such a manner as to distend them with blood.

Nervous system. The general features of this system can be easily seen in specimens preserved in formalin, and still better in those cleared in suitable medium. This species is especially favorable for tracing the course of the smaller nerves peripherally, for even small branches appear with great distinctness in suitably stained, serial sections. This system, however, has already been so fully described by Bürger ('09) for *P. rollestoni*, that only minor details require mention here.

The lateral nerves show clearly a larger, ventral, fibrous core and a much smaller dorsal one. In one series of sections the thin layer of delicate longitudinal muscles on the medial border of the nerve shows quite distinctly. These nerve-cord muscles are described more fully for *P. joubini* (Plate 25, fig. 161).

The posterior nerve-commissure is in close proximity to the anastomosis of the ends of the lateral blood-vessels. Usually the union of the nerves is immediately posterior to that of the blood-vessels, but the relations are occasionally reversed. In one series of transverse sections the union of the blood-vessels was a single section anterior to that of the nerves.

In all cases the lateral nerve and blood-vessels are closely associated, and are not separated by the ovaries, as Bürger ('09) finds in *P. rollestoni*, but both lie together along the inner, or occasionally the outer, border of the ovaries.

Sense-organs. On each side of the tip of the head is a group of peculiar organs situated directly beneath the cephalic walls. These resemble the organs which Brinkmann figured for *P. rollestoni*, and which he thought to be rudimentary ocelli. That they are actually sense-organs is proved by the fact that they are connected with distinct nerves. In the present species they are situated on the ventral side of the anterior border of the head beside and a little anterior to the opening of the rhynchodeum. There are about six pear-shaped organs in each group, from the inner, pointed end of which the nerve leads toward the brain. Their ventral position argues against their being rudimentary eyes, but the preservation of the tissues involved is unfavorable for a study of the histological details.

Bürger ('09) found somewhat similar sense-organs on the lateral margins of the head in Balaenanemertes, and he presents such evidence as he can find to support his hypothesis that they represent rudimentary eyes. No trace of pigment-cup is found, however; neither is the cellular complex or the nerve-relations such as occurs in nemertean ocelli. Their occurrence in at least three species of pelagic nemerteans, and the presence of large and apparently functional nerves indicate that the organs are functionally active.

For the present they should be added to the somewhat long list of nemertean sense-organs whose functions are unknown. They may properly be provisionally termed "pyriform sense-organs."

A distinct dorsal nerve in the usual position between the basement-layer and body-musculature extends throughout the entire length of the body. It increases in size near the middle of the body.

Reproductive organs. In the earlier accounts of this genus as given by Moseley (1875a) and Hubrecht (1887) only the female was available for study.

Bürger ('09) first described the male, with its cephalic spermaries, from a single specimen of *P. rollestoni*. In this specimen there were five spermaries on one side of the head in front of the brain and six on the other. These gonads were closely crowded together, each with a duct opening on the ventral side of the tip of the head and lateral to the rhynchodeal opening. The spermaries were large and saccular, the posterior ends of the sacs extending backward to the brain-region. Brinkmann ('16) examined two young males of that species, finding them to agree essentially with Bürger's description.

The collections of the U. S. Fish Commission contain thirteen males of *P. brinkmanni*. Here the sexual conditions are very similar to those which Bürger ('09) has described, but with important specific distinctions, as will be indicated below.

The ovaries of *P. rollestoni* consist of four or five pairs of spherical bodies situated on the ventral surface along the sides of the body close to the lateral nerves. In *P. moseleyi* there are seven or eight ovaries on each side, and alternating with the intestinal diverticula, while in *P. brinkmanni* the number is from six to eight, but averages about seven.

In *P. brinkmanni* the sexes are easily distinguished after preservation in formalin, and this is doubtless even more true of the living worms, because the transparency of the body allows the gonads to be seen distinctly. In some specimens, as shown in Plate **2**, the ovaries are of relatively enormous size and of a yellowish color, their opacity rendering them highly conspicuous among the translucent tissues.

The males, on the contrary, are most easily distinguished by the absence of ovaries, but the sex is accurately determined by the presence on each side of the proboscis-opening of a cluster of small rounded bodies, sometimes so crowded as to appear as lobules of a single opaque organ. These represent the spermaries, reduced in this species to five or occasionally six or seven pairs of small ovoid gonads (Plate **2**, fig. 9).

In some specimens (Plate **2**, fig. 11; Plate **26**, fig. 165) these spermaries lie on the outside of the head instead of being imbedded in its tissues. In such cases there appears to be a cluster of conical or globular external appendages on each side of the mouth. This puzzling condition has evidently arisen from the change in pressure which the animal has undergone in passing from a great depth to the surface of the ocean, just as fishes and other animals are often eviscerated under similar conditions. Close examination by means of sections shows that the tissues of the head have been ruptured and the gonads squeezed out of the tissues beyond the surface of the head. They are either separately or collectively surrounded by small shreds or masses of the gelatinous tissue of the head. It is hardly probable that any contraction of the feeble body-musculature could cause such a rupture of the tissues. Even in very small and evidently young specimens the sex can be distinguished by the position of the rudimentary gonads.

Spermaries. In their normal position the spermaries lie close against the anterior margins of the head (Plate **2**, fig. 9; Plate **26**, fig. 164; Figure 104), with openings of all grouped subterminally to the right and left of the mouth. In a much contracted specimen in which the proboscis is in process of eversion (Plate **26**, fig. 163) the anterior part of the body has become thicker and narrower, causing the brain and the accompanying spermaries to sink deep into the tissues of the head.

The spermaries vary considerably in size and shape according to the contraction of the surrounding tissues and also with the degree of development of the genital products. In a typical case (Plate **26**, fig. 164, 166) each spermary is ovate, and somewhat pointed at both ends. Surrounding each gonad is a strong musculature consisting of a single layer of spirally arranged muscle-fibers (Plate **26**, fig. 166), similar to those described for Nectonemertes and as Brinkmann ('12) found in Phallonemertes. In some of the gonads the distal portion is strongly contracted, forcing the mature spermatozoa into the larger, rounded middle portion (Plate **26**, fig. 166). The musculature ends near base of the efferent duct, which is lined with a flat columnar epithelium. The muscular fibers lie as parallel as possible, and each is provided with a spindle-shaped nucleus. The fibers often show beautifully the several finer fibrils of which each is composed.

In several of the specimens in this collection as mentioned above, the spermaries had been forced through ruptures in the cephalic walls, giving them the appearance of external appendages on the anterior surface of the head, to the right and left of the mouth (Plate **2**, fig. 11; Plate **26**, fig. 165). When sections are made of such projecting spermaries it is found that each gonad remains attached to its duct, the latter being imbedded firmly in the cephalic walls as in the normal condition. The rupture has taken place through the thin dorsal wall of the tip of the head on each side of the rhynchodeal opening, the gelatinous tissue flowing out to some extent with the gonads. An empty space is left in the gelatinous tissue of the head on each side in front of the brain.

Germinal cells in various stages of development, including ripe spermatozoa, occupy most of the space within the muscular wall of the gonad. Outside is a delicate framework of parenchyma fibers holding the gonad in place in the gelatinous tissue.

The function of the spiral musculature is presumably to supplement the action of the very weak cephalic walls in discharging the spermatozoa during the act of insemination, for it seems allowable to assume the contact of the two sexes and internal fertilization as the general rule among bathypelagic nemerteans.

Ovaries. There are typically six or seven pairs of ovaries (Plate **2**, fig. 10, 13–15; Plate **26**, fig. 162; Figures 44 B, 103), which are situated between the intestinal diverticula. There is some variation in the number, however, for additional ones may be interpolated in the normal series, and one or more may be missing. Nor are they disposed at regular spacial intervals, for the available area for their development is limited by the configuration of the enormous intestinal diverticula.

In general, the first three or four pairs are located between the first and second pairs of diverticula, with a single pair anterior to both the third and fourth pairs of diverticula and the sixth or seventh pair of ovaries behind the fourth pair of diverticula. This leaves the anterior and posterior fifths of the body free from gonads. Sometimes there are two distinct ovaries in the space usually occupied by one.

For each ovary, even when the ova have reached a size only half that of full maturity, the oviducts are fully formed and open by an oblique slit on the ventral surface of the body, in proximity to the lateral nerve. Some of the ovaries lie on the lateral side of the nerve-cord and others on the medial side and the oviducts have the same relations.

Each ovary produces, as in other bathypelagic forms, but a few very large ova. In the early stages of development of the gonad there are many potential ova, but in their later growth the number is gradually reduced. From one to three of the young ova increase enormously in size by the addition of yolk formed in the follicular syncytium, while the others become aborted (Plate **28**, fig. 176, 176a). Finally but one or two remain to absorb by their protoplasmic connections with a peripheral layer of yolk-forming cells the greater part of the substance of the others. The latter join the abortive ova in the peripheral syncytial layer.

Plate **28**, fig. 176a shows a late stage in this process. In this figure are seen sections of the three larger ova which this ovary contained. In one of these the nucleus and nucleolus are shown. The cytoplasm and yolk-material of all are seen to be directly continuous with a peripheral layer which consists of a syncytium containing the nuclei of yolk-forming follicle-cells and the primitive ova which are abortive and in process of degeneration. This peripheral layer elaborates the yolk-material which is then taken directly into the egg-cells through their pseudopodial connections. Eventually one or two of the ova gain supremacy over the others, and assimilate into themselves the entire substance of the other ova and of the follicle-cells.

Hermaphroditic gonad. In one of the specimens from Station 4785 the spermaries projected in front of the head due to the rupture of the cephalic tissues from pressure. Sections show that one of the projecting gonads contains, in addition to very numerous spermatocytes, seven amoeboid ova essentially similar to those described for the hermaphroditic glands of *Proarmaueria pellucida*. In another small gonad a single ovum was found. These were first thought to be unicellular parasites, but careful examination shows that each ovum is connected peripherally with a thin layer of cytoplasm with many nuclei, constituting a rudimentary peripheral syncytium. In another specimen from the same locality one gonad had a single ovum of similar appearance. There seems little doubt, therefore, that an occasional hermaphroditic gonad occurs in this species, suggesting a derivation from an hermaphroditic ancestor. A section of the larger hermaphroditic gonad, showing five of the ova among numerous spermatocytes, is figured on Plate 28, fig. 177.

Geographical distribution. The twenty-three specimens of this new species collected on the Northwest Pacific expedition included thirteen males and ten females. They were taken at the following localities in May and June, 1906.

1. Station 4759. Lat. 53° 05′ N., Long. 138° 31′ W.; depth about 4000 m. Two plankton-nets 36 cm. in diameter and one intermediate net about 2 meters in diameter were drawn horizontally for twenty minutes at a depth of about 600 m. and then raised vertically to the surface. One male with partially everted proboscis.

2. Station 4760. Lat. 53° 53′ N., Long. 144° 53′ W.; depth about 4400 m. Same apparatus as at Station 4759 drawn at 600 m. One large female with six pairs of large ovaries. One male with small spermaries. One large sexually mature male, with the spermaries on one side forced through the cephalic tissues.

3. Station 4766. Lat. 52° 38′ N., Long. 174° 49′ W.; depth about 3600 m. Here also same apparatus was used as at Station 4759 and was likewise drawn

at 600; one male with mature spermaries imbedded in cephalic tissues but projecting slightly.

4. Station 4767. Lat. 54° 12′ N., 179° 0.75′ E.; Bowers Bank, Bering Sea. Depth about 1600 m. Same apparatus as at Station 4759, drawn at a depth of about 600 meters (400 fms. wire) for twenty minutes and then hauled vertically to surface. One female, 12 mm. long by 8 mm. wide, having seven pairs ovaries and unusually numerous and unsymmetrical intestinal diverticula (Plate 2, fig. 14).

5. Station 4775. Lat. 54° 33.5′ N., 178° 44′ E.; Bowers Bank, Bering Sea. Depth about 1200 m. Same apparatus as at Station 4759, drawn at about 400 meters (275 fms. wire) for fifteen minutes. Seven specimens were secured. Four of these were males, one being 8 mm. in length by 4 mm. in width, with a group of six immature spermaries on each side; another was 9 mm. by 4 mm., with five spermaries on each side; the other two males were each about 15 mm. by 6 mm., with five mature spermaries, having fully formed efferent ducts, on each side of the head. Each of the three females was about 12 mm. long and 5 mm. wide, with six or seven pairs of ovaries.

6. Station 4785. Lat. 53° 20′ N., Long. 170° 33′ E.; depth about 3700 m. Same apparatus as at Station 4759 drawn at about 600 m. One large male, 18 mm. by 7 mm. (Figure 1); one male with projecting spermaries, one of which also contains seven amoeboid ova; two males with projecting spermaries; one very small male (6 mm. in length), with inconspicuous spermaries; one large female with mature ovaries; two females with small ovaries; and one injured female with small ovaries — making a total of nine specimens from this one haul.

7. Station 4797. Lat. 52° 37.5′ N., Long. 158° 50′ E., depth about 1400 m. Same apparatus as at Station 4759 drawn for twenty minutes at about 600 m. and then vertically to surface. One female with rather small ovaries, each of which contains one egg larger than the three or four others.

Inspection of Plate 30 will show that the seven stations at which this species was taken are all in the North Pacific ocean, off the southern coast of Alaska, in the vicinity of the Aleutian Islands, in Bering Sea, and off the east coast of Kamchatka. The depth of the water in these localities is between 1400 and 4400 meters, but all the specimens were secured in nets drawn at a depth of about 600 meters for twenty minutes and then raised vertically to the surface. The stations east of Kamchatka were inadvertently omitted from Plate 30.

Since no specimens were secured at stations where the nets were drawn at less than about 600 meters it is reasonably certain that the species is truly bathypelagic. There is no definite information as to the particular zone of water the worms frequent most abundantly, however; it is only certain that they occur at about 600 meters, but whether they are more or less abundant, or whether they occur at all, below this level the material at hand does not indicate.

Nor do we know the exact temperature of the 600-meter water-layer. However, since the surface-temperature was about 40°–46° F. in early summer when the specimens were taken, while the bottom-temperature was about 35°–36.6° we may feel confident that the worms live in a fairly constant temperature not far from 38° F.

It is significant that although the same methods of securing specimens of the bathypelagic life were employed at numerous stations between Kamchatka and the waters off the eastern coast of Japan, as well as in the Japan Sea, no additional nemerteans of this species were taken.

Dredgings off the southern coast of Japan likewise failed to secure any representatives of *P. moseleyi*, the only known specimen of which was taken by the CHALLENGER expedition at one of the same localities. This somewhat meager evidence indicates a fairly wide geographical separation between the two species.

GELANEMERTES, gen. nov.

Body short and broad anteriorly, tapering gradually posteriorly; without caudal fin; proboscis-sheath nearly as long as the body; proboscis more than twice the length of body; intestinal diverticula not very numerous, not much branched; spermaries in a single row on each side of brain.

The single species for which it is necessary to provide this new genus was described by Joubin as *Pelagonemertes richardi* but the arrangement of the spermaries excludes it from that genus, with which it otherwise agrees in many features.

37. GELANEMERTES RICHARDI (Joubin).

Pelagonemertes richardi JOUBIN, Bull. Mus. océan., 1906, no. 78, p. 21, fig. 17, 18.

Plate **3**, fig. 24, 25.

Figure 105.

Joubin's superficial description and the accompanying photographs indicate a soft, flattened, translucent body, widest anteriorly and tapering gradually to the posterior extremity, which is without a caudal fin (Figure 105).

Digestive system. There are approximately twenty-five pairs of intestinal diverticula, apparently with small lobes but without distinct branches.

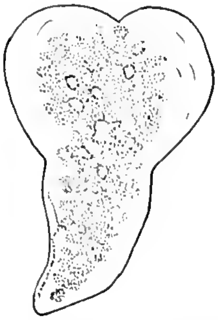

FIG. 105.—*Gelanemertes richardi* (Joubin). × 4. (After Joubin, 1906).

Proboscis-sheath and proboscis. The rhynchocoel extends almost the entire length of the body and the proboscis has a length more than twice as great.

Reproductive organs. The single known specimen was a male with five pyriform gonads in a single row on each side of the head.

Geographical distribution. The specimen was taken by the PRINCESS ALICE expedition in the North Atlantic Ocean (Lat. 30° 36′ N., Long. 26° 05′ W.).

PARABALAENANEMERTES Brinkmann.

Bergens mus. skrift., 1917, ny raek., 3, no. 1, p. 118.

This genus is characterized as being of medium size, without tentacles, with only an indication of a caudal fin; intestinal tract deeply pigmented, with few diverticula; proboscis-sheath nearly as long as the body; dorsal blood-vessel rudimentary.

Only a single species, *P. fusca*, is definitely known to have the characteristics of this genus, but it seems not improbable that a form superficially described by Joubin as *Planktonemertes zonata* may also belong here.

38. PARABALAENANEMERTES FUSCA Brinkmann.

Bergens mus. skrift., 1917, ny raek., 3, no. 1, p. 118, pl. 14, fig. 1–17.

The three specimens of this species thus far studied were so badly preserved that little is known regarding their form or appearance in life. The intestinal diverticula contain such a large amount of pigment that the entire body except head, margins of body, and ovaries appears to be of a dark brown color. Of the anatomical features described by Brinkmann, the following are of particular interest.

Size. One of the specimens measured, after preservation, 7 mm. long by 3 mm. wide, and 2 mm. thick; another was about 21 mm. long by 6 mm. wide, and only 1.5 mm. thick; while the third was 10 mm. in length.

Alimentary canal. The mouth is separated from the rhynchodeal opening; the former opens directly into a remarkably short, narrow stomach which passes into the pylorus in the brain-region. The narrow intestinal canal has about fifteen pairs of large, branched diverticula. The caecum is very short, terminating in a pair of branched diverticula, while a second pair of diverticula joins the canal at the point where the pylorus opens into the intestine.

Proboscis and proboscis-sheath. The proboscis-sheath extends almost the entire length of the body, and the proboscis is more than twice as long. There are twelve proboscidial nerves. The armature of the proboscis consists of a basis bearing at least fourteen stylets and of at least seven small pouches of accessory stylets.

Nerve-cord muscle. In the brain-region a slender band of muscular fibers separates from the musculature of the proboscis-sheath and runs along the medial border of the lateral nerve throughout the entire length of the body. It is not so well developed, however, as in Balaenanemertes and Cuneonemertes.

Blood vascular system. As in Pelagonemertes, the dorsal vessel is very rudimentary, ending blindly within the rhynchocoel a short distance behind its origin from the ventral cephalic anastomosis.

Nervous system. The dorsal nerve is well developed, extending backward nearly to the posterior union of the lateral nerves. There are commissures between the dorsal nerve and those branches from the dorsal core of the lateral nerves which spread out in the dorsal body-musculature and beneath the basement-layer.

Reproductive organs. The single known male specimen had three oval spermaries on one side of the head and five on the other side. They lie just lateral to the brain and open by corresponding groups of papillae on either side of the rhynchodeal opening. As in many other forms, the spermary is provided with a muscular layer beneath the connective tissue capsule.

Each of two females had ten pairs of ovaries, the first pair lying just behind the brain and the last pair in the caudal region.

Parasites. In one of the specimens there were found both in the brain and in the parenchyma groups of small unicellular parasites similar to those described for *Nectonemertes primitiva.*

Geographical distribution. The three known specimens were taken at separate stations in the North Atlantic (Lat. 46° 30′ N., Long. 7° W.; Lat. 54° 51′ N., Long. 28° 15′ W.; Lat. 54° 05′ N., Long. 26° 08′ W.), at depths of about 1800, 850, and 650 meters respectively. As the depth of the water at the station first mentioned is 4000 meters, and as specimens of *Nectonemertes mirabilis* were also taken at each of the latter stations, the two species appear to be limited to the same layers of water, namely those having a temperature of less than 6° C. and a salinity not exceeding 35%.

39. PARABALAENANEMERTES (?) ZONATA (Joubin).

Planktonemertes zonata JOUBIN, Bull. Mus. océan., 1906, no. 78, p. 11, fig. 8.

Plate 3, fig. 21.

Two specimens of doubtful affinities were collected by the PRINCESS ALICE expedition (1905). One of these was 6-7 mm. and the other 9–10 mm. in length. The latter was of a brownish color in life, with about a dozen clearer, transverse bands.

The proboscis-sheath was not described, and the proboscis-armature was not discovered.

The body seems to have been about three times as long as broad, rounded in front, narrowing gradually and only moderately flattened. The body terminates in a flattened, but slightly developed caudal fin.

The reproductive organs are indicated by a series of about twelve small papillae on the ventral surface of each side of the body. The figure indicates that these papillae are disposed at fairly regular intervals except on the head and at the posterior extremity. They are doubtless oviducts, indicating that both specimens were females.

Geographical distribution. Both of the known specimens came from near the Azores; one from Lat. 38° 4′ N., Long. 26° 7.5′ W., and the other from Lat. 37° 4′ N., Long. 28° 1′ W. In both cases the specimen was taken in the pelagic net from 3000 meters to surface.

The generic position of these two specimens is uncertain, pending information regarding the character of proboscis-sheath, proboscis-armature, and other anatomical features on which the genera are diagnosed, but because of the size, shape, and color of one of the specimens and the other superficial characters mentioned by Joubin they may be provisionally placed with Parabalaenanemertes. The twelve lighter bands across the brownish body suggest corresponding spaces between intestinal diverticula filled with brown pigment. *P. fusca* has fifteen pairs of intestinal diverticula. These, together with two pairs of caecal diverticula, also bear a dark brown pigment, making the superficial resemblance very close.

PROBALAENANEMERTES Brinkmann.

Bergens mus. skrift., 1917, ny raek., 3, no. 1, p. 122.

Body small, much flattened; with distinct caudal fin; without tentacles; intestinal diverticula with division into dorsal and ventral branch.

Only a single species of this genus has been described.

40. PROBALAENANEMERTES WIJNHOFFI Brinkmann.

Bergens mus. skrift., 1917, ny raek., **3**, no. 1, p. 122, pl. 12, fig. 16–21.

Figure 106.

But a single representative of this species is known. It was only about 8 mm. long, 3.5 mm. wide in the broadest part and 2 mm. thick. The proboscis-sheath extends backward as far as the base of the caudal fin. The proboscis was lost. A slender nerve-cord muscle is present.

The mouth and proboscis-opening are separate. There are about fifteen pairs of intestinal diverticula, of which each of the first ten divide into a dorsal and a ventral branch, the one passing above and the other beneath the lateral nerve. The short caecum has three pairs of diverticula similar to those of the intestine.

The dorsal vessel ends in a blind enlargement shortly after entering the rhynchocoel.

The specimen was a mature female, which had discharged the eggs from all except two ovaries. The empty sacs showed that there had been eight ovaries on one side and nine on the other, all of which opened ventrally between the lateral vessel and lateral nerve. This specimen was taken in the North Atlantic (Lat. 56° 5′ N., Long. 30° 31′ W.) at a depth of about 800 meters, proving its pelagic habits.

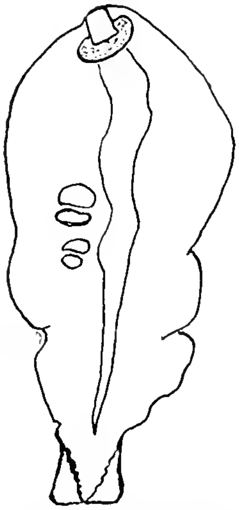

FIG. 106.—*Probalaenanemertes wijnhoffi* Brinkmann. Outline of body, showing extent of proboscis-sheath and two of the ovaries. × 8. (After Joubin, 1917a).

Joubin ('06) describes under the name *Planktonemertes sargassicola* a specimen of about the same size and shape as the above, but states that the mouth and proboscis have a common opening. For this reason the two specimens must be placed provisionally in separate genera although they are similar in appearance. In case the study of Joubin's specimen shows that it belongs to this genus and is specifically identical with *P. wijnhoffi* the name *sargassicola* has priority. If Joubin's description is correct, however, his species is to be placed in the new genus Mononemertes, as is done in this report.

BALAENANEMERTES Bürger.

Wissens. ergebn. Valdivia, 1909, **17**, p. 204.

Body short and stout; swollen anteriorly; bearing a pair of tentacles back of head in both sexes; caudal fin well developed; mouth and proboscis-opening separate; intestinal diverticula few; nerve-cord muscle usually well developed; spermaries in clusters beside or in front of brain.

Seven species have been described up to the present time. They may be distinguished by the following key:—

A.	Proboscis-sheath about two thirds as long as body	B.
AA.	Proboscis-sheath extends nearly the entire length of body	C.
B.	Intestine with about 11 pairs of diverticula	*B. chuni.*
BB.	Intestine with about 36 pairs of diverticula	*B. chavesi.*
C.	Intestinal caecum with but one pair of diverticula or none	D.
CC.	Intestinal caecum with two pairs of diverticula	E.
D.	Intestinal caecum without diverticula	*B. musculocaudata.*
DD.	Intestinal caecum with one pair of diverticula	*B. lobata.*
E.	Intestinal caecum without median lobe anterior to diverticula	*B. lata.*
EE.	Intestinal caecum with median lobe anterior to diverticula	F.
F.	Intestinal diverticula with dorsal and ventral branches, proboscis attachment-muscles present; 7–8 spermaries on each side of brain	*B. hjorti.*
FF.	Intestinal diverticula without distinct dorsal and ventral branches; proboscis attachment-muscles absent; 4–7 spermaries on each side of brain	*B. grandis.*

41. BALAENANEMERTES CHUNI Bürger.

Wissens. ergebn. Valdivia, 1909, **17**, p. 204; Brinkmann, Bergens mus. skrift., 1917, ny raek., **3**, no. 1, p. 132.

Figure 107.

Of this interesting form, which is the type of the genus, only a single specimen has as yet been found. The appearance in life is unknown, but after preservation the body was ovoid, with a distinct caudal fin (Figure 107). The anterior third of the body bears a pair of short lateral appendages homologous with the tentacles of Nectonemertes and quite similar in appearance to those of young males of that genus. The structure of the appendage is, however, much simpler than in Nectonemertes, the musculature consisting mainly of dorsoventral fibers. By means of these muscles the appendages are flattened to form a pair of lateral horizontal fins. They are doubtless of use in floating and swimming and may also be of service at the time of discharging the sexual products, as has been suggested for the tentacles of Nectonemertes (Brinkmann '16; Coe '20).

This specimen measured 9 mm. in length, 4 mm. in width, and 3 mm. in thickness.

Alimentary canal. The mouth and proboscis-opening are separate; the oesophagus is much reduced, and the stomach passes into the pylorus in the posterior brain-region. The intestinal caecum extends forward somewhat anterior to the brain-commissures. It is provided with a single pair of very large diverticula in addition to several rudimentary lobes near the posterior end (Figure 107).

Proboscis-sheath. The proboscis-sheath is limited to the anterior two thirds of the body. This is in marked contrast with the condition found in most of the more recently described species of the genus, in which the sheath extends nearly the entire length of the body.

Proboscis. The proboscis is nearly as long as the body and is armed with a crescentic basis bearing upwards of a dozen closely placed, minute, conical stylets. There are fourteen to sixteen proboscidial nerves.

Nerve-cord muscle. A remarkable development in this species is a longitudinal band of large muscular fibers extending in close contact with the lateral nerves throughout their entire length. Bürger ('09) states that this lateral nerve-musculature originates in the brain-region in connection with the muscles of the proboscis-sheath and extends along the ventromedial border of the nerve even beyond the posterior extremity of the latter. The muscular band consists exclusively of longitudinal fibers. In its posterior portions it equals the lateral nerve in diameter. Bürger considers that this structure is not homologous with the delicate muscular fibers found within the nerve-sheath in Drepanophorus, Pelagonemertes, and others. However, since the two musculatures differ only in position and in the size and abundance of their constituent fibrils, it seems more reasonable to conceive of both as special modifications of a musculature which accompanies the nerve-cords in other groups of worms.

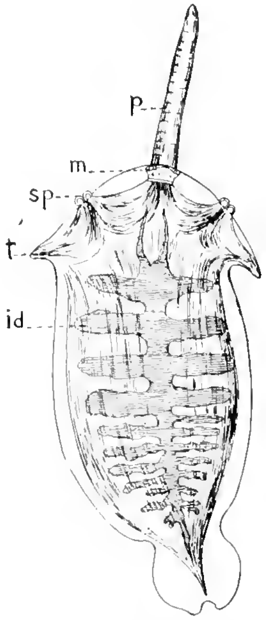

FIG. 107.— *Balaenanemertes chuni* Bürger. Outline of body of male with everted proboscis, after preservation, showing the short tentacles (*t*), the openings of the spermatic ducts (*sp*), the intestinal diverticula (*id*) and the separate openings of mouth (*m*) and proboscis. (After Bürger, 1909).

Nervous system. The brain exhibits three lobes on each side; a two-lobed dorsal ganglion and the ventral ganglion. One lobe of the dorsal ganglion accompanies the ventral ganglion in the formation of the lateral nerve, and forms its dorsal fibrous core, as in most other pelagic nemerteans.

Sense-organs. Some five or six of the cephalic nerves on each side of the head end in peculiar sense-organs situated immediately beneath the integument. Each of these organs consists of a compact group of cells surrounded by a thin membrane, and with the nerve leading from its basal portion directly toward the brain. Brinkmann ('16) has observed similar organs in *Pelagonemertes vanhöffeni*, and they are recorded for *P. brinkmanni* in this report. Both of the investigators mentioned consider these organs rudimentary, or degenerate ocelli, but there are serious objections to this view, some of which are stated in the systematic account of *P. brinkmanni*. In the head of *B. chuni*, Bürger also found numerous, still smaller, rounded groups of cells, some of which lie next the basement-layer, and others deeper in the cephalic parenchyma. These are probably also special sense-organs of some kind.

Vascular system. The lateral vessels present no peculiarities, but it is stated that there is not even the rudiment of the dorsal blood-vessel.

Reproductive organs. The only known specimen of this species was a male with five pairs of spermaries. These are situated in a compact group on each side immediately behind the brain. Each gonad opens on the summit of a minute papilla on the lateral border of the head (Figure 107). The epithelium covering the body in the immediate vicinity of the genital papillae is composed mainly of slender gland-cells filled with a finely granular, greenish secretion.

Geographical distribution. The single specimen known was collected in the Indian Ocean at the same station as *Chuniella pelagica*, namely, Lat. 29° 6.2′ S., Long. 89° 39′ E. The depth is here 2500 meters; but the specimen was taken in a vertical haul of the net and hence there is no direct evidence as to the depth at which the species lives.

42. BALAENANEMERTES MUSCULOCAUDATA Brinkmann.

Bergens mus. skrift., 1917, ny raek., **3**, no. 1, p. 124, pl. 1, fig. 7, pl. 15, fig. 1–16.

Plate **1**, fig. 8.

Figure 108, 109.

As shown in Plate **1**, fig. 8, the body is short, broadest anteriorly, tapering gradually nearly to the posterior end and then broadens into a conspicuous bilobed caudal fin. Several specimens measured from 7 to 10.5 mm., in length, by 2.5 to 4 mm., in width, and from 1.25 to 2.3 mm. in thickness.

Color. The color of the digestive system in life is yellow, giving this color-effect to the whole body except head, tentacles, lateral margins, and caudal fin. The color is deeper in the posterior half of the body. The brain-lobes appear as reddish brown spots. The anterior half of the body is translucent, the posterior portions being more opaque (Plate **1**, fig. 8).

Body-walls. The circular muscles are very thin, but the longitudinal musculature is of unusual thickness, consisting of four broad bands, two on the dorsal and two on the ventral side of the body. These muscular bands are connected medially by a layer about half as thick, but these are almost lacking along the lateral margins. In the caudal region they are extraordinarily thick in the median line, providing for powerful movements of the caudal fin. The dorsoventral fibers are much reduced.

Digestive system. The mouth, which is separated from the proboscis-opening, leads directly into the stomach, and the latter passes into the pylorus in the brain-region. There are about twenty pairs of slightly lobed intestinal diverticula, but the caecum is peculiar in that it is without appendages.

Vascular system. The median vessel ends blindly in the rhynchodeum a short distance behind the brain.

Proboscis and proboscis-sheath. The rhynchocoel extends to the posterior end of the body. The muscular walls of the sheath are a direct continuation of the proboscis-musculature, the longitudinal muscles of the proboscis continuing posteriorly and dorsally from the proboscis-insertion to become interlaced with the longitudinal muscles of the cephalic walls. Similar muscle-bundles pass from the ventral wall of the proboscis to the ventral cephalic walls. The united effect of both these sets of muscles results in a very firm attachment of the proboscis to the cephalic walls as is described in more detail for *Pelagonemertes brinkmanni.*

The proboscis is provided with seventeen or eighteen nerves, and with a short, thick and but slightly curved basis bearing at least fifteen small stylets. The retractor is divided into two parts, one being attached to each of the lateral walls of the posterior end of the sheath.

Nervous system. The ventral ganglia are larger than the dorsal, but show the usual relations with the rest of the nervous system. The dorsal nerve is well developed; its ends anteriorly without connection with the dorsal brain-commissure.

Sense-organs. There are two groups of minute, rounded sense-organs on the anterior border of the head. These have been looked upon as rudimentary ocelli. Each is directly connected with large nerves originating from the anteromedial border of the brain-lobes.

Reproductive organs. All of the five known specimens of this species were males. The six to eight oval spermaries (Figure 109) on each side are closely grouped beside the brain. The sperm-ducts project anteriorly beyond the cephalic tissues on either side of the proboscis-opening (Figure 108). There is a single layer of muscle-cells beneath the firm connective tissue wall of the gonad.

Geographical distribution. The five known specimens were all taken well toward the northern part of the North Atlantic (Lat. 54°–59° N., Long. 7°–23° W.) at the moderate depths 400–700 meters.

At each of the three stations at which this form occurred there were also taken one or more female specimens of *B. lobata*, a form similar in size, and shape, but differing greatly in color and also apparently in regard to the intestinal diverticula. It is still uncertain whether these represent separate species or the sexually differentiated males and females of a single, sexually dimorphic species.

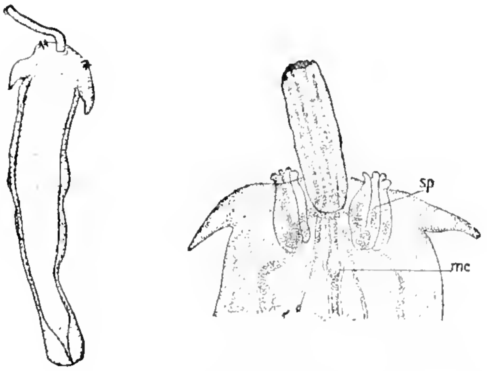

Fig. 108, 109.—*Balaenanemertes musculocaudata* Brinkmann. Fig. 108. Male with partially everted proboscis, showing groups of spermaries projecting on each side anterior to the tentacles. × 4.5. Fig. 109. Anterior portion of body, showing the groups of spermaries (*sp*) with their projecting sperm-ducts between the partially everted proboscis and the tentacles; *mc*, middle chamber of proboscis. After Brinkmann (1917a).

43. Balaenanemertes lobata (Joubin).

Brinkmann, Rept. Michael Sars, 1917, **3**, p. 17; Bergens mus. skrift., 1917, ny raek., **3**, no. 1, p. 128, pl. 1, fig. 8, pl. 16, fig. 1–15

Nectonemertes lobata Joubin, Bull. Mus. océan., 1906, no. 78, p. 20, fig. 16.

Plate **1**, fig. 7.

Figure 110, 111.

Seven females closely resembling *B. musculocaudata* in anatomical peculiarities were carefully studied by Brinkmann and identified with some hesitation as specifically identical with the single male superficially described by Joubin.

These specimens were very similar to *B. musculocaudata* in form and size, and in their internal peculiarities. They differed strikingly, however, in color, as indicated below, but this may have been due to sexual differentiation, for the five known specimens referred to *B. musculocaudata* were all males. Both forms were associated at three stations in the same hauls. Furthermore both forms agree in the arrangement of the vascular, nervous, and proboscidial systems, and are essentially alike as regards the digestive system except that the intestinal diverticula are more widely separated and the caecum has a pair of large diverticula in *B. lobata,* whereas the intestinal diverticula are closely placed and the caecum is without diverticula in *B. musculocaudata.* The tentacles of *B. lobata* arise somewhat farther back on the side of the head than is the case in *B. musculocaudata*, and the muscular walls of the body are decidedly thinner in the latter than in the former species. These differences may, perhaps, as Brinkmann himself suggests, be looked upon as secondary sexual characters, the position and extent of the diverticula being influenced by the development of the ovaries. Pending further information, however, it seems advisable to retain both specific names, particularly as Joubin's male seems to agree in its general appearance more closely with the females of *B. lobata* than with the males of *B. musculocaudata.*

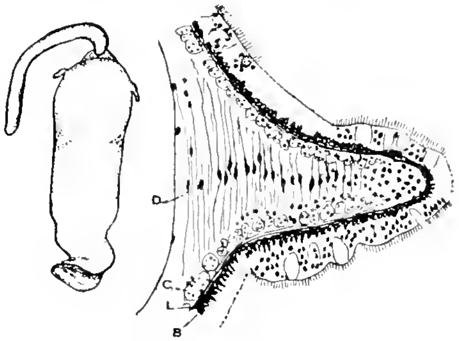

FIG. 110, 111.—*Balaenanemertes lobata* (Joubin). Fig. 110. Mature female with everted proboscis. ×4.5. Fig. 111. Longitudinal vertical section of contracted tentacle, showing the complete absence of an inner longitudinal musculature; D, dorso-ventral muscles; C, circular muscles; L, longitudinal muscles; B, basement-layer, with its corrugated surface for the attachment of the overlying epithelium. × 108. After Brinkmann (1917a).

Color. The digestive system is deep reddish lilac in color and because of its extent gives this general tone to the body. The nervous system is dark red, and the ova orange-yellow. The rest of the body is perfectly transparent and colorless.

Reproductive organs. Each of the seven specimens studied by Brinkmann had seven or eight pairs of fully developed ovaries (Plate **1**, fig. 7). Each gonad matures but a single large ovum, which eventually becomes as much as a millimeter in diameter, or more than one tenth the entire length of the worm. It is therefore apparently impossible for all of the ovaries to produce such large eggs at the same time, so that the fully mature gonads alternate with more or less regularity with those in an earlier stage of development (Plate **1**, fig. 7).

The numerous primitive ova which each young ovary contains serve as nutritive material for the single large egg which reaches full development.

The male reported by Joubin had the genital papillae closely grouped beside the rhynchodeal opening.

Geographical distribution. The seven females were collected in the northern portion of the North Atlantic ocean (between Lat. 48° and 59° N., and between Long. 7° and 32° W., at a depth of from about 400 to 2000 meters. Joubin's specimen came from somewhat farther south (Lat. 36° 17′ N., Long. 28° 53′ W.), in a vertical haul from 3000 meters.

44. BALAENANEMERTES CHAVESI (Joubin).

Brinkmann, Bergens mus. skrift., 1917, ny raek., **3**, no. 1, p. 134.

Nectonemertes chavesi JOUBIN, Bull. Mus. ocean., 1906, no. 78, p. 16, fig. 13, 14.

Plate **3**, fig. 23.

Figure 112.

The single specimen to which Joubin gave this name has been but superficially studied and may prove to be specifically identical with *B. lobata* or one of the other species of the genus. This specimen was about 9.5 mm. long and 3.5 mm. wide. The short tentacles are situated well back on the sides of the head. The body is translucent after preservation, but the colors in life are unknown. The intestinal diverticula probably exceed thirty pairs. This specimen was a male with a group of spermaries on each side of the brain.

Geographical distribution. North Atlantic Ocean (Lat. 36° 17′ N., Long. 28° 53′ W.); one specimen taken in a vertical haul from 3000 meters.

45. BALAENANEMERTES GRANDIS Brinkmann.

Bergens mus. skrift., 1917, ny raek., 3, no. 1, p. 134, pl. 15, fig. 17.

Two specimens are referred to a separate species because they differ from others of the genus in lacking the dorsal and ventral muscular bands which in other species pass from the insertion of the proboscis to the cephalic walls. These specimens are of somewhat larger size than in other species, although the larger of the two measured only 14 mm. in length by 3 mm. in width, with a thickness of only 1.5 mm.

Among the distinguishing anatomical features should be mentioned the two large caecal diverticula, the short dorsal vessel, which ends almost immediately after entering the rhynchocoel, the sixteen proboscidial nerves, and the position of the sperm-ducts scattered on the anterolateral borders of the head. Both specimens were males, one having four spermaries on one side and five on the other, while the second had five and seven respectively.

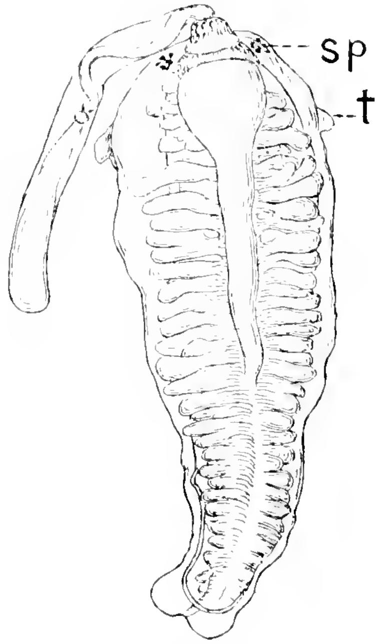

FIG. 112. *Balaenanemertes chavesi* (Joubin). Dorsal side of male with fully everted proboscis, showing the groups of spermaries (*sp*) on each side of the proboscis opening: *t*, tentacle. (After Joubin, 1906).

Geographical distribution. Thus far known only from the northern North Atlantic (Lat. 59°–61° N., Long. 7°–17° W.); one specimen from a depth of about 660, and the other from 1200 meters.

46. BALAENANEMERTES HJORTI Brinkmann.

Rept. Michael Sars, 1917, 3, p. 18; Bergens mus. skrift., 1917, ny raek, 3, no. 1, p. 135, pl. 14, fig. 18–22.

This species is based on a single male 10 mm. long and 4 mm. wide, with short tentacles and particularly well-developed caudal fin. The most important distinguishing feature of the species is the presence of a thick, longitudinal muscle-bundle between the ventral brain-commissure and the stomach, presumably connected with the insertion of the proboscis. There are two pairs of caecal diverticula, and the intestinal diverticula send branches to the ventral as well as to the dorsal side of the lateral nerves. The spermaries are rounded and not closely pressed together.

Geographical distribution. One specimen from the North Atlantic (Lat. 48° 29′ N., Long. 13° 55′ W.) at a depth of about 1000 meters.

47. BALAENANEMERTES LATA Brinkmann.

Rept. Michael Sars, 1917, **3**, p. 18; Bergens mus. skrift., 1917, ny raek., **3**, no. 1, p. 136, pl. 16, fig. 16–18.

Only a single specimen of this species is known at present. This was 11.4 mm. long and had very small tentacles. It differed from all other species in having the intestinal caecum forked anteriorly into two large diverticula, each with two branches, of which the dorsal branch extended in front of the brain. Behind these there is a pair of smaller diverticula. The radial muscles from the proboscis-insertion are voluminous, but, unlike *B. hjorti*, very few of these pass between the stomach and the ventral commissure. The spermaries are in two dense clusters, beside and anterior to the brain.

Geographical distribution. Known only from the North Atlantic (Lat. 48° 04′ N., Long. 32° 25′ W.), from about 1300 meters.

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EXPLANATION OF THE PLATES.

The following abbreviations are used generally; in exceptional cases other symbols are employed, and these are explained in the descriptions of the figures.

ac	anterior chamber
am	attachment-muscles
ao	abortive ova
at	atrium
bl	blood-lacuna
bm	basement-membrane
br	brain
bv	lateral blood-vessel
bva	blood-vessel anastomosis
bw	body-wall
c	caecum
cd	caecal diverticula
cf	caudal fin
cm	circular muscles
cn	caudal nerve
cv	cephalic vessel
cvd	caudal vessel
dc	dorsal commissure
dcl	dorsal layer of nerve-cells
dg	dorsal ganglia
did	dorsal lobe of intestinal diverticulum
dln	dorsolateral nerve
dn	dorsal nerve
dp	dorsal peripheral nerve
dv	dorsal vessel
dvm	dorsoventral muscles
e	oesophagus
ep	epithelium
gc	gastric caecum
gd	genital-duct
gl	ganglion (?), problematical organ
gt	gelatinous tissue
i	intestine
ic	intestinal caecum
icd	diverticulum of intestinal caecum
icm	inner circular muscular layer
id	intestinal diverticulum
ilm	inner longitudinal muscular layer
imp	intermuscular plexus
in	integument
lm	longitudinal muscle
lmp	longitudinal muscle of proboscis
ln	lateral nerve
lp	lateral peripheral nerve
lv	lateral blood-vessel
m	mouth
mc	middle chamber of proboscis
mu	muscle
mv	median vessel
n	nerve
nc	nerve-commissure
ncm	nerve-cord muscle
np	nerve-plexus
nu	nucleus
o	ovum
ocm	outer circular muscles
od	oviduct
ov	ovary
p	proboscis
pa	posterior anastomosis
pam	proboscis attachment-muscle
pap	papilla of proboscis
par	parenchyma
pc	posterior chamber of proboscis
pcm	circular musculature of proboscis
pe	proboscis-epithelium
pi	proboscis-insertion
plm	longitudinal musculature of proboscis
pm	proboscis-musculature
pn	proboscis-nerve
pnc	posterior nerve-commissure
pr	proboscis-retractor
ps	proboscis-sheath
py	pylorus
r	rectum
rc	rhynchocoel
rd	rudimentary diverticulum
rh	rhynchodeum
ro	rhynchodeal opening
sd	sperm-duct
sm	stomach-muscle
sp	spermary
spc	spermatocyte
spg	spermatogonium
spt	spermatids
spz	spermatozoa
st	stomach
sv	seminal vesicle
syn	syncytium
t	tentacle
v	ventral lobe
va	ventral anastomosis
vc	ventral brain-commissure
vcl	ventral cellular layer
vg	ventral ganglion
vid	ventral branch of intestinal diverticulum
vn	ventral nerve
vp	ventral peripheral nerve
x	see explanation of figure

Figures 9, 29–31, 50–53, 103, 106, 116, 117 were drawn by Miss Lisbeth Krause; Figures 10, 13, 113, 114 by Dr. S. C. Ball; most of the others by the author.

PLATE 1.

PLATE 1.

Fig. 1. Planktonemertes agassizii Woodworth. Drawing made by Alexander Agassiz from living individual taken at Station 3388. Slightly enlarged.

Fig. 1a. Planktonemertes agassizii Woodworth. Female with large, opaque ovaries. Drawing by W. McM. Woodworth from preserved specimen. × $1\frac{3}{4}$.

Fig. 2. Neuronemertes aurantiaca Coe. Type specimen from Station 4615. Drawn by Alexander Agassiz from living individual. × $1\frac{1}{2}$.

Fig. 3. Nectonemertes mirabilis Verrill. Fully mature male with extended tentacles. Preserved specimen, unusually broad and flattened; collected by U. S. Fish Commission steamer ALBATROSS. × 3.

Fig. 4, 5. Nectonemertes mirabilis Verrill. Male and female respectively. From sketches of living animals, showing the body much more slender and less flattened than in preserved specimen shown in Figure 3. In both individuals the proboscis is partially extruded. After Brinkmann (1917a). × 3.

Fig. 6. Nectonemertes pelagica Cravens & Heath. Female from Station 4669. Drawn from living animal by Alexander Agassiz. Natural size.

Fig. 7. Balaenanemertes lobata (Joubin). From ventral surface of mature female, showing the small tentacles, the dark red brain and lateral nerves, the outline of the digestive system and the orange colored ova of various sizes. × 10. After Brinkmann (1917a).

Fig. 8. Balaenanemertes musculocaudata Brinkmann. Mature male, showing the protruding spermatic ducts on either side of the partially everted proboscis. The tentacles are fully developed. The digestive system is yellow and the brain reddish brown. × 10. After Brinkmann (1917a).

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PLATE 2.

PLATE 2.

Pelagonemertes brinkmanni Coe.

Fig. 9. Dorsal view of sexually mature male from Station 4785, in which the yellow coloring of the digestive canal remains after preservation in formalin. On each side of the brain are the five rounded spermaries. The narrower rhynchocoel, extending almost the entire length of the body, is seen above the intestine. Of the six diverticula on each side of the intestine the anterior four are in pairs, and the sixth on the right-hand side is bilobed. The brain and nerve-cords are conspicuous in the translucent gelatinous tissue of the body. × 8.

Fig. 10. Ventral view of mature female from Station 4760. Digestive canal is white; ovaries yellow. Intestinal diverticula less symmetrical than in most other specimens. Six pairs of ovaries with fully developed ova; the most posterior ovary on one side is double. The lateral nerves distinctly seen as slender white cords. × 5.

Fig. 11. Ventral view of sexually mature male from Station 4760. Spermaries are displaced by contraction of the body and project forward as lobes on each side of the rhynchodeal opening. Intestinal diverticula less numerous than usual. × 5.

Fig. 12. Dorsal view of a very young male from Station 4760. The gonads are very immature, but may be identified on each side of rhynchodeal opening. The four pairs of intestinal diverticula are symmetrical. × 4.

Fig. 13. Side view of fully mature female, also from Station 4760, showing the white digestive tract and the large yellow ovaries, with the oviducts already formed. × 5.

Fig. 14. Female from Station 4767, showing seven pairs of ovaries, with oviducts widely opened, and unusually numerous intestinal diverticula. Length after preservation, 12 mm.

Fig. 15. Immature female from Station 4767, showing seven pairs of small ovaries and somewhat asymmetrical intestinal diverticula. × 4.


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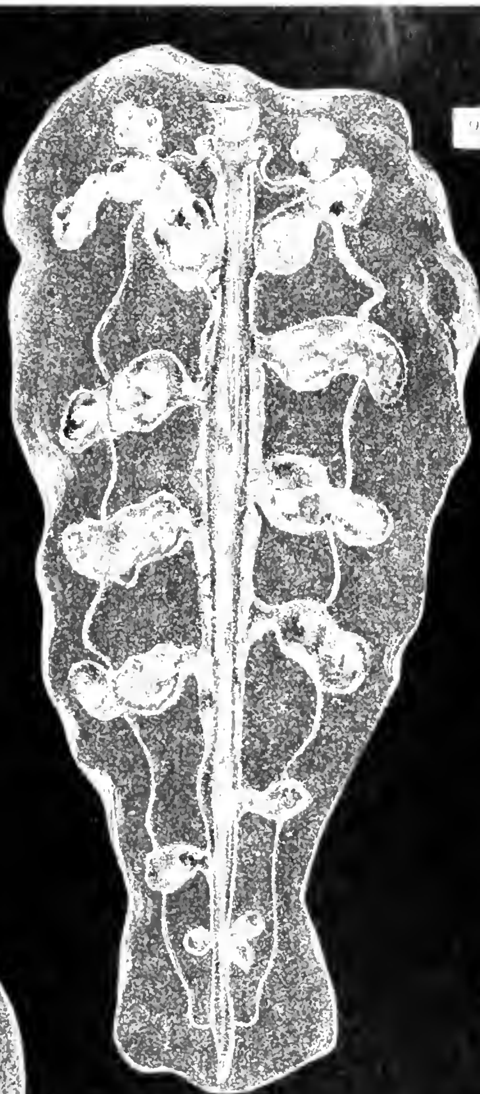
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PLATE **3**.

PLATE **3**.

Fig. 16. Pelagonemertes brinkmanni Coe. Photograph of mature male after being cleared and mounted in damar, showing the cephalic spermaries, the intestinal diverticula and the nerve-cords through the transparent body-tissues. × 4.

Fig. 17. Photograph of female of same species, showing the six pairs of half-grown ovaries. × 4.

Fig. 18, 19. Nectonemertes mirabilis Verrill. Photographs of ventral and dorsal surface respectively, of mature male with contracted tentacles. On the ventral side of the head may be seen minute papillae, indicating the openings of the sperm-ducts. The photographs show the extremely thin horizontal and caudal fins. × 3.

Fig. 20. Planonemertes lobata Coe. Male with mature spermaries. × 3.

Fig. 21. Parabalaenanemertes (?) zonata (Joubin). (After Joubin 1906). × 4½.

Fig. 22. Chuniella (?) elongata (Joubin). (After Joubin 1906). × 5.

Fig. 23. Balaenanemertes chavesi (Joubin). (After Joubin 1906). × 5½.

Fig. 24, 25. Gelanemertes richardi (Joubin). Dorsal and ventral views. (After Joubin 1906). × 5.

Fig. 26. Crassonemertes (?) rhomboidalis (Joubin). (After Joubin 1906). × 6.

Fig. 27, 28. Dinonemertes grimaldii (Joubin). (After Joubin 1906). Ventral and dorsal views. × 1¼.

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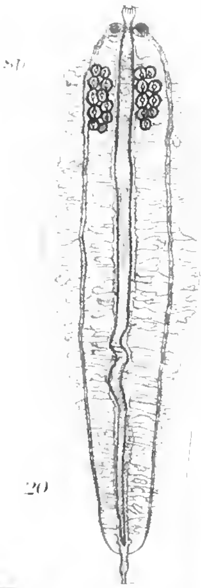

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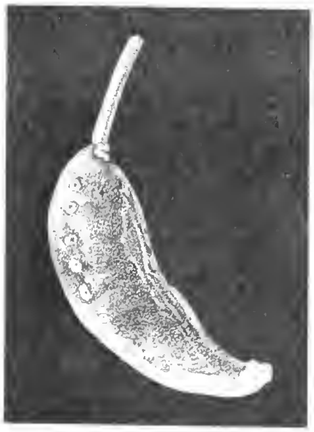

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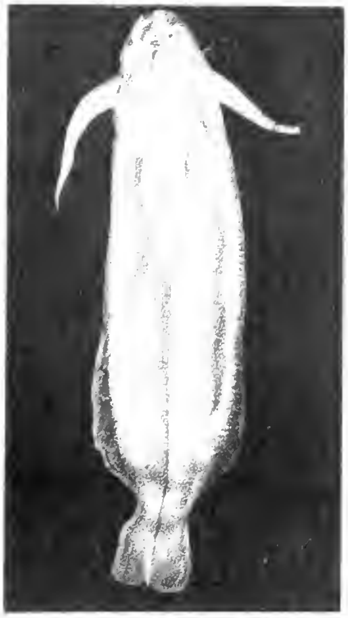

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PLATE **4**.

PLATE 4.

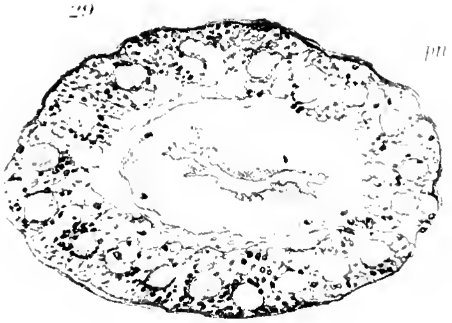
Fig. 29. Pelagonemertes brinkmanni Coe. Transverse section of proboscis near anterior end, showing the thick layer of longitudinal muscles between the thin outer circular layer and the almost rudimentary inner circular layer. The inner epithelium, which rests upon a very thick layer of gelatinous tissue, had been dislodged before preservation, as in the case of the integument. There are nineteen distinct proboscidial nerves (*pn*), without communicating nerve-plexus in this region. × 85.

Fig. 30. Pelagonemertes brinkmanni Coe. Transverse section of proboscis near middle of anterior chamber, showing the very thick mass of gelatinous tissue which underlies the inner epithelium in life, although the latter has been almost entirely dislodged. The nineteen proboscidial nerves (*pn*) are connected by a distinct plexus which separates the two longitudinal muscular layers. × 85.

Fig. 31. Pelagonemertes brinkmanni Coe. Transverse section through middle chamber of proboscis, showing interwoven radial and oblique muscular fibers in the proboscis-wall and the muscular attachment of the crescentic stylet-basis. Only fifteen of the nineteen proboscidial nerves (*pn*) have retained their identity, in this region. The inner epithelium is present on the greater part of the lumen, but is badly preserved. × 85.

Fig. 32. Pelagonemertes joubini Coe. Transverse sections of the everted proboscis, showing the relation of the nervous and other layers in both anterior and posterior chambers. In the outer section the most distal layer is the papilliferous epithelium (*pap*), which is shown but for a small portion of the circumference. The nervous layer shows fifteen large nerves (*pn*) and an equal number of secondary nerves (*pn'*). A delicate intermuscular plexus (*imp*) lies between the longitudinal (*lm*) and inner circular (*icm*) muscular layers, sending fine nerve-fibers to the epithelium of the papillae. A still more delicate nervous plexus (*imp'*) is formed just beneath the outer circular muscles (*ocm*). The cells of the endothelial covering (*ep*) are compressed into a columnar form, due to the contraction resulting from eversion. The inner section, through the posterior chamber, shows the thin muscular wall, with columnar, glandular epithelium lining the lumen. × 85.

Fig. 33. Neuronemertes aurantiaca Coe. Portions of two transverse sections through the body immediately posterior to the pylorus, the right-hand half-section being cut through an intestinal diverticulum, while in the left-hand half the plane of the section passes through an interdiverticular space and shows the relations of the three peripheral nerves leading from the lateral cord to the musculature and the intermuscular plexus (*imp*); *bm*, basement-layer; *did*, dorsal lobe of intestinal diverticulum; *dp*, dorsal, *lp*, lateral, and *vp*, ventral peripheral nerves; *dln*, dorsolateral nerve; *dn*, dorsal nerve; *dvm*, dorsoventral muscles; *ps*, proboscis-sheath; *vid*, ventral lobe of intestinal diverticulum. Somewhat diagrammatic reconstruction from several adjacent sections. × 28.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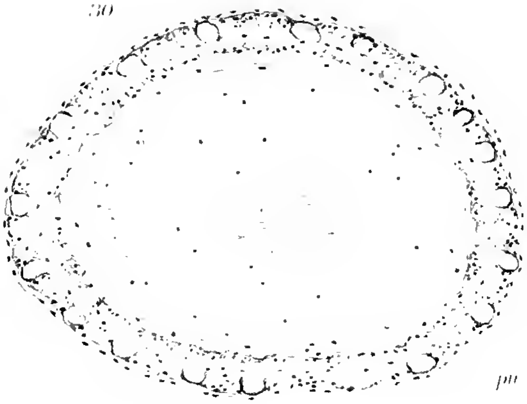
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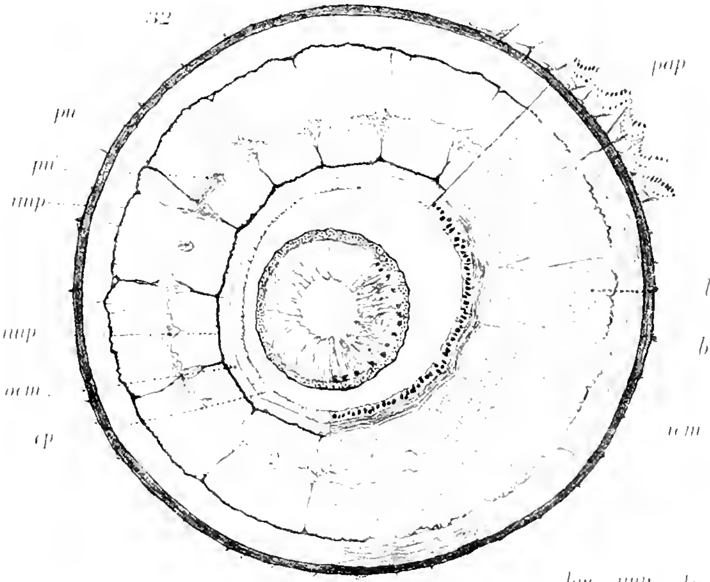
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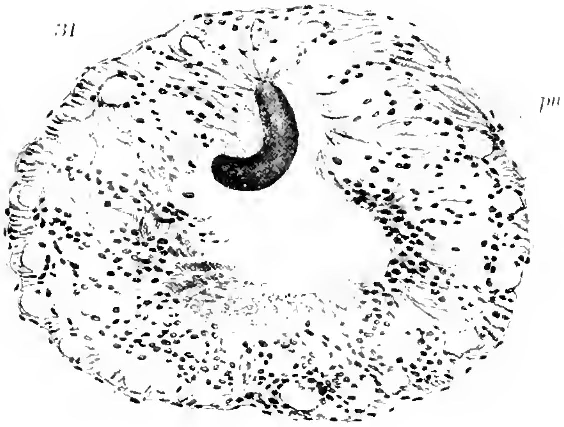
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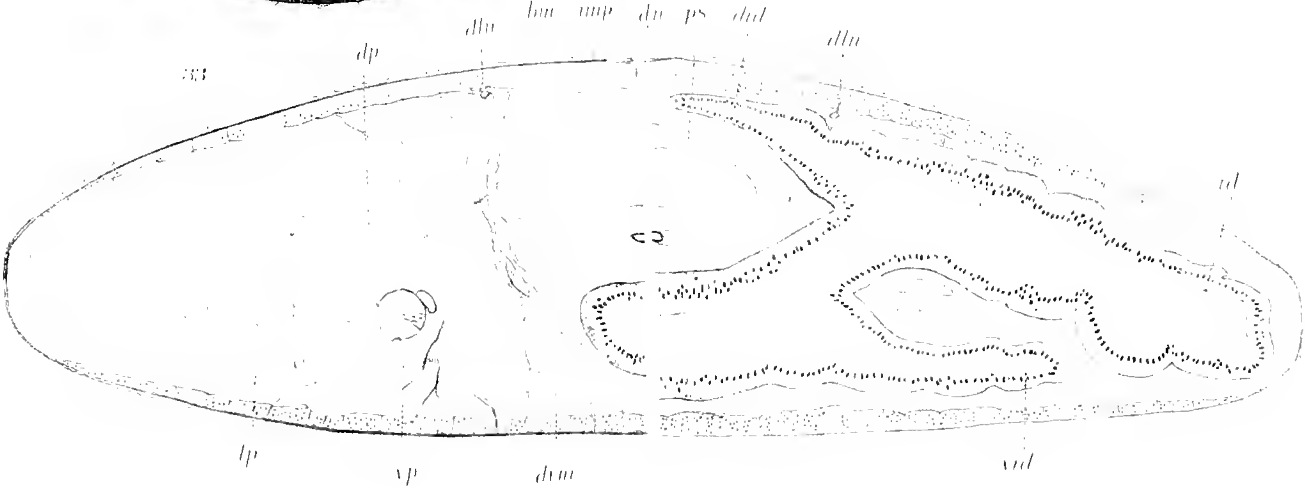
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PLATE 5.

PLATE 5.

Planktonemertes agassizii Woodworth.

Fig. 34. Specimen from Station 3361, measuring 24 mm. in length of body, with the proboscis extruded as in normal eversion to a length of about 28 mm. Female, with about twenty-seven pairs of small ovaries, each with several immature egg-cells; *x* indicates point of attachment of proboscis to wall of sheath.

Fig. 35. Female from Station 3383, showing a few large ovaries. Drawn by W. McM. Woodworth. × $1\frac{1}{4}$.

Fig. 36. Female from Station 3388, in which the ovaries were very immature. Drawn by W. McM. Woodworth. × $1\frac{1}{4}$.

Fig. 37. Smaller specimen from Station 3388 with relatively few very large ovaries. × 4.

Fig. 38. Wax-model of brain, reconstructed from serial sections by W. McM. Woodworth.

Fig. 39. Small portion of longitudinal section of body-wall, showing interlacing of dorsoventral muscles with the musculatures of the body-wall.

Fig. 40. A few ciliated cells, accompanied by two gland-cells, from the epithelium of the pylorus.

Fig. 41. Intestinal epithelium, showing the two types of cells, vacuolated and granular.

Fig. 42. Portion of sagittal section through head, showing two of the proboscis attachment-muscles (*am*), which hold the ring of insertion (*pi*) firmly anchored in the tissues of the head; *at*, atrium (from which the lining epithelium has been dislodged); *bm*, basement-layer, on which the epithelium (*ep*) is present only on the ventral surface; *cm*, and *lm*, circular and longitudinal muscles of cephalic wall; *dc* and *vc*, dorsal and ventral brain-commissures; *icd*, diverticulum of intestinal caecum; *lmp*, longitudinal muscles of proboscis; *par*, parenchyma; *pp*, papillae of proboscis; *ps*, proboscis-sheath; *py*, pylorus; *rc*, rhynchocoel. × 25.

Fig. 43. Portion of sagittal section, showing the closely crowded dorsal branches of the intestinal diverticula (*id*), the smaller ventral branches (*id′*); a nearly mature ovum (*ov*), cut through the nucleus, is connected by protoplasmic bridges with the small amount of peripheral yolk remaining; a second ovum (*ov′*) is accompanied by a single abortive egg-cell, also in connection with the peripheral yolk. The fibrous dissepiments between the diverticula show delicate dorsoventral muscles and numerous branches of the ventral peripheral nerves (*vpn*), the latter indicated by solid black lines. × 25.

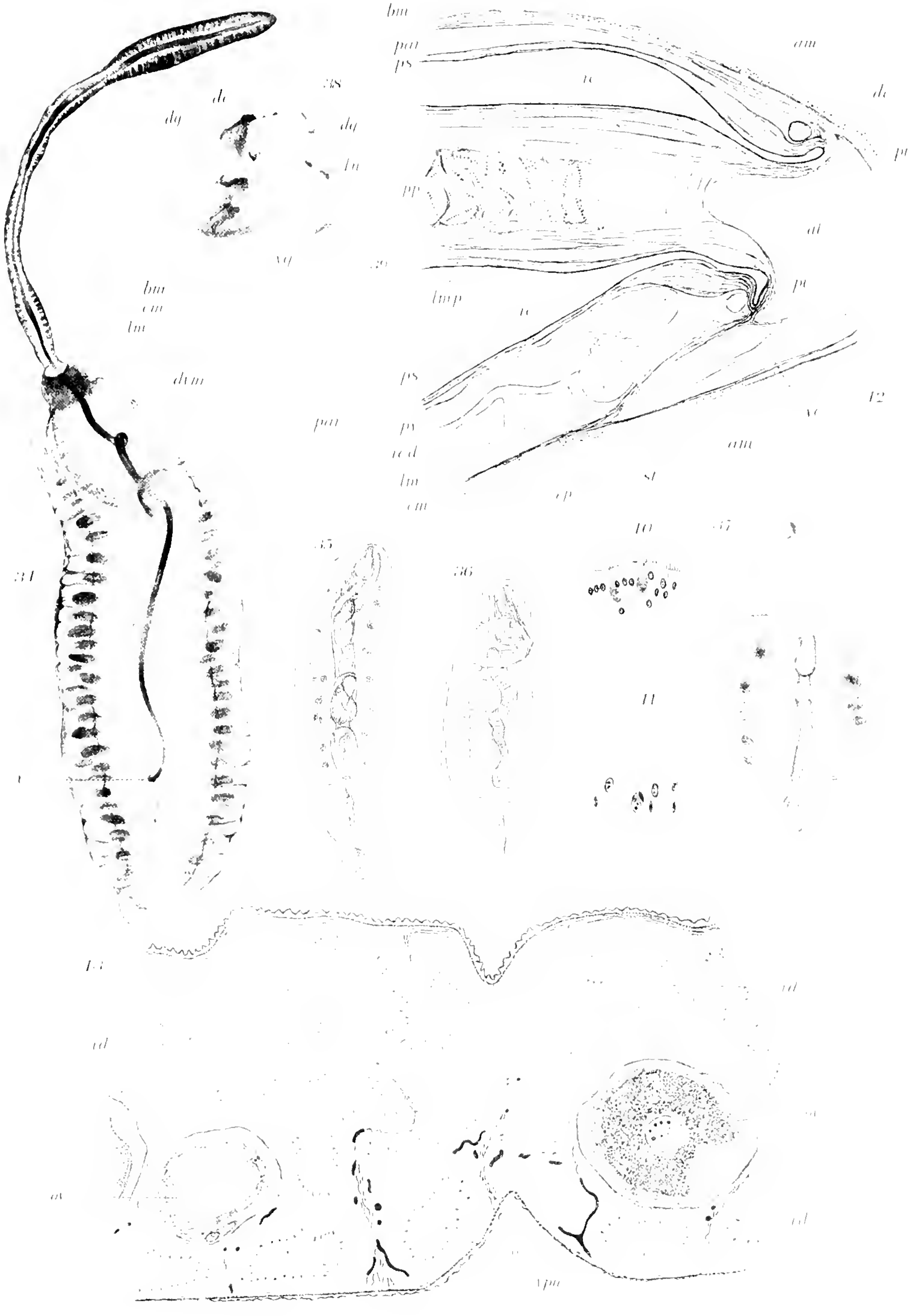
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PLATE 6.

PLATE 6.

Planktonemertes agassizii Woodworth.

Fig. 44. Longitudinal section of wall of anterior proboscis-chamber, showing the high corrugations and papillae which bear the lining epithelium, here mostly dislodged.

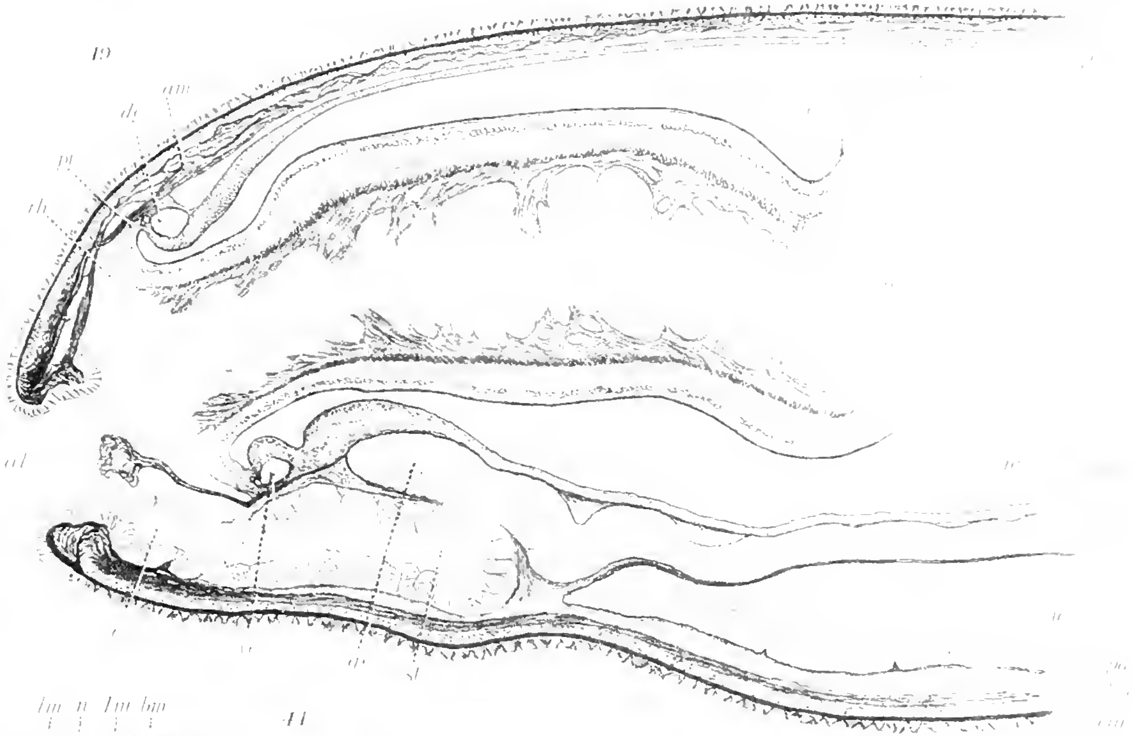
Fig. 45. Optical section of fully everted proboscis, showing the crescentic or hook-shaped basis projecting freely at the end. Below the basis are two groups of gland-cells; *ac*, corrugated lining of anterior chamber; *pc*, posterior chamber; *rc′*, space between walls of everted anterior and posterior chambers, filled with rhynchocoel fluid.

Fig. 46. Basis, showing stylets and radial musculature.

Fig. 47. Stylets, showing variations in form and size.

Fig. 48. Optical sections of stylet and basis.

Fig. 49. Sagittal section through median portion of head-region, showing common opening of mouth and rhynchodeum. The epithelial covering of body as well as that lining the rhynchodeum has been dislodged during capture, leaving the corrugated basement-membrane (*bm*) exposed. The attachment-muscles (*am*) of the proboscis (*p*) immediately in front of the dorsal brain-commissure (*dc*) are shown. The oesophagus (*e*) is directly continuous with the stomach (*st*), at the posterior end of which one chamber leads anteriorly to form the gastric caecum (*gc*) and another backward to form the long slender pylorus (*py*). Beneath the latter lies the intestinal caecum (*ic*). Other lettering indicates:— *at*, atrium, leading to rhynchodeum (*rh*); *rc*, rhynchocoel; *ps*, proboscis-sheath; *vc*, ventral brain-commissure; *lm*, and *cm*, longitudinal and circular musculature of body-walls. × 25.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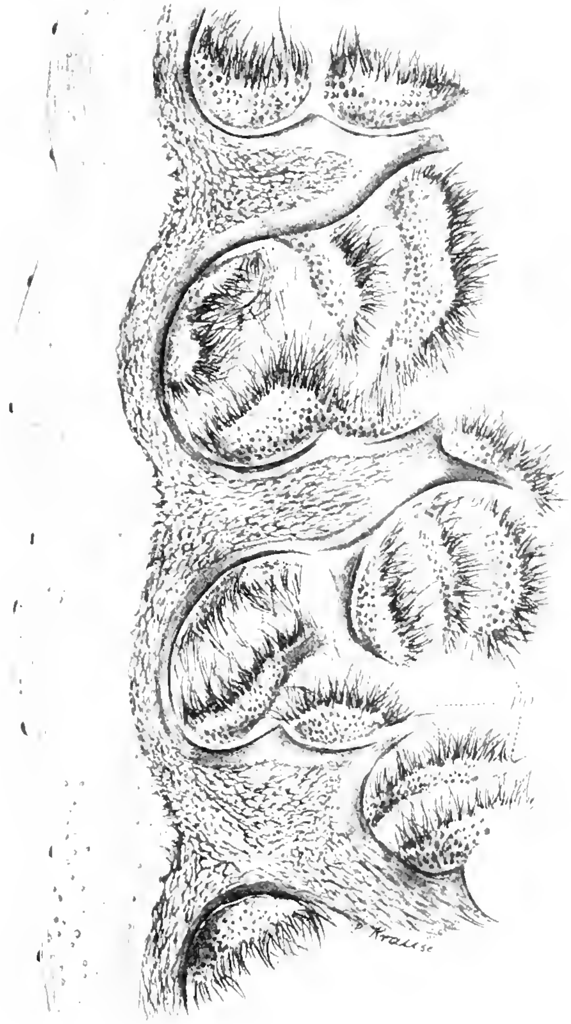
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PLATE **7**.

PLATE 7.

Planktonemertes agassizii Woodworth.

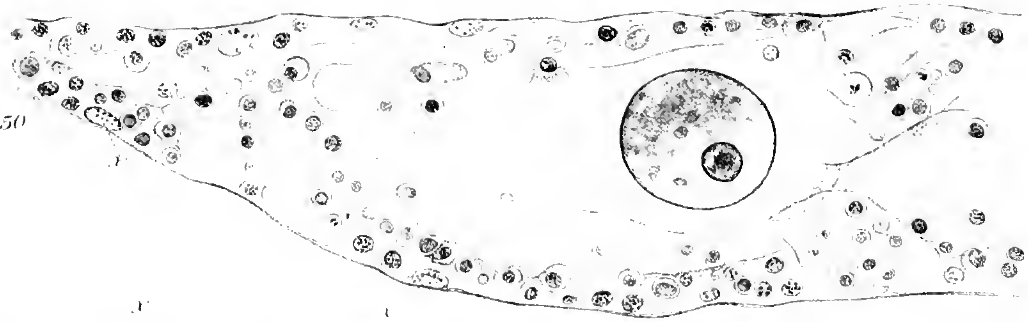
All figures enlarged 400 diameters.

Fig. 50, 51. These two figures placed end to end form a single complete section of a young ovary showing four large amoeboid ova with some of their pseudopodial processes connected with the syncytium lining the ovarian wall. A few oval, granular nuclei (x) belonging to the connective tissue of the wall are found beneath the smaller and more rounded nuclei of the syncytium. (Compare Plate 8, fig. 55).

Fig. 52. A single amoeboid ovum showing its slender pseudopodial connections with the peripheral syncytium. A loose follicle-cell (x) is in the metaphase of karyokinetic division.

Fig. 53. A single amoeboid ovum with numerous protoplasmic processes associated with the follicular syncytium.

Fig. 54. Small portion of an ovary in a more advanced stage of development, showing two of the amoeboid ova with short pseudopodia imbedded in the syncytial mass which fills the entire ovary. The protoplasmic matrix is crowded with groups of yolk-granules and vacuoles of lipoid secretion. The nuclei of the syncytium have become relatively very small.



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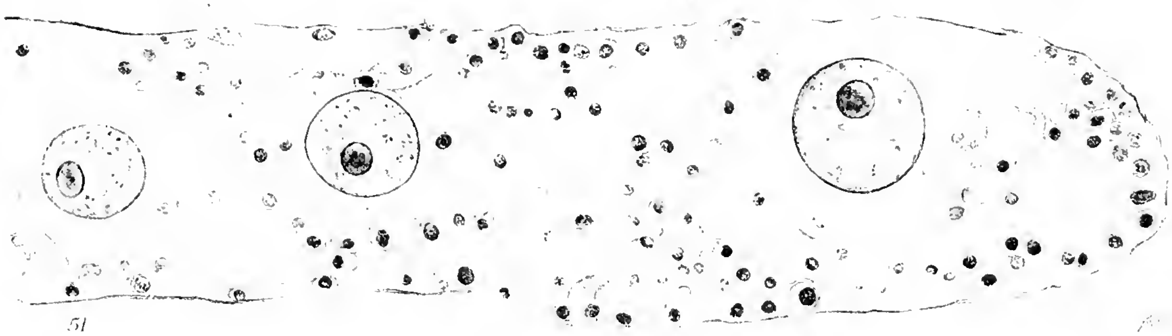

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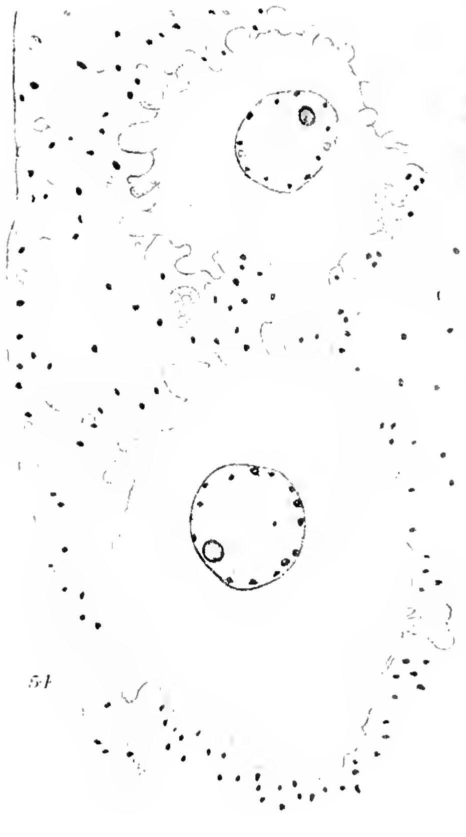

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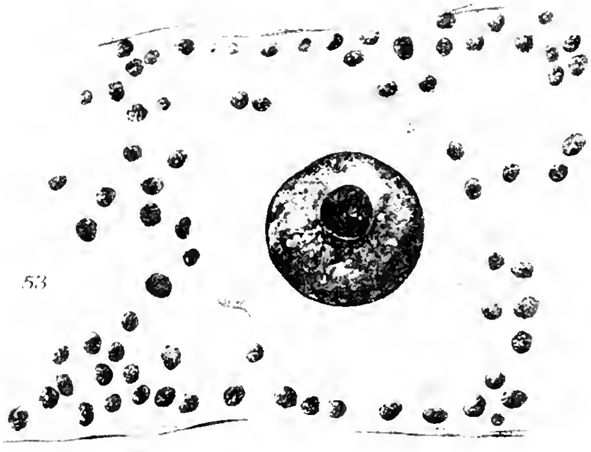

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PLATE 8.

PLATE 8.

Planktonemertes agassizii Woodworth.

Successive stages in the development of the ova.

All magnified to the same scale of 85 diameters.

Fig. 55. A young ovary, showing the amoeboid ova lying in the ovarian cavity and connected with the follicular cells of the syncytium by protoplasmic processes only. (Compare Plate **7**, fig. 50, 51).

Fig. 55a. Two amoeboid ova with protoplasmic processes joining syncytium.

Fig. 56. Somewhat later stage in which the ovarian cavity has become filled by the growth of the syncytium and the follicle-cells distended with yolk-globules. Four amoeboid ova are shown, of which the one nearest the center is apparently destined to become the definitive egg-cell.

Fig. 57. An ovary in which two of the ova have become surrounded by a layer of yolk-forming cells, while the two others in the section still retain their amoeboid processes and are destined to become aborted.

Fig. 58. The definitive egg-cell is clearly distinguishable by its larger size, central position, and pseudopodial connections with the syncytium. Three abortive amoeboid ova (*ao*) are shown on the periphery, with others in process of degeneration. The oviduct (*od*) penetrates the body-wall as far as the circular muscular layer.

Fig. 59. Ovary with two eggs of equal size separated and surrounded by the yolk-bearing syncytium. Two small abortive ova (*ao*) are shown.

Fig. 60. Portion of a nearly mature ovum, drawn to the same scale as the above, in which the syncytial yolk-mass has become relatively thin and is connected with the cytoplasm of the egg by only slender bridges of protoplasm. The nucleus is shown in a section from near the center of the egg. Three abortive ova are indicated.


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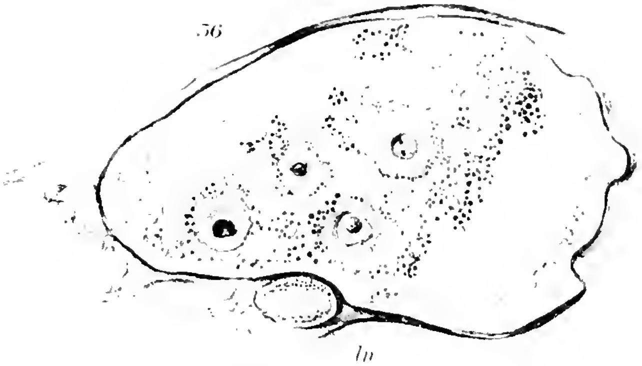
55a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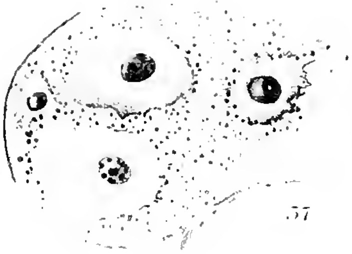
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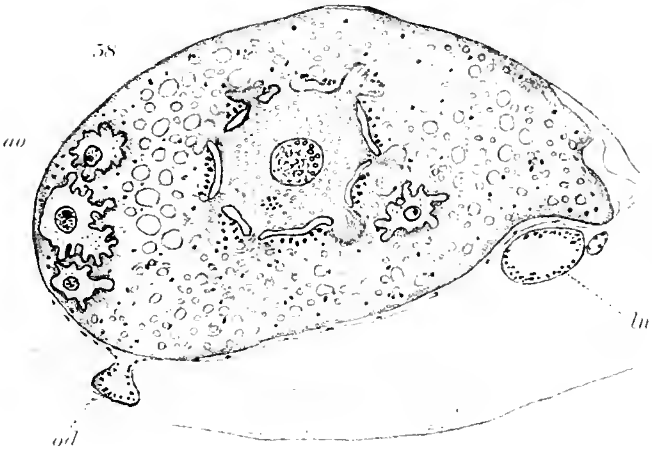
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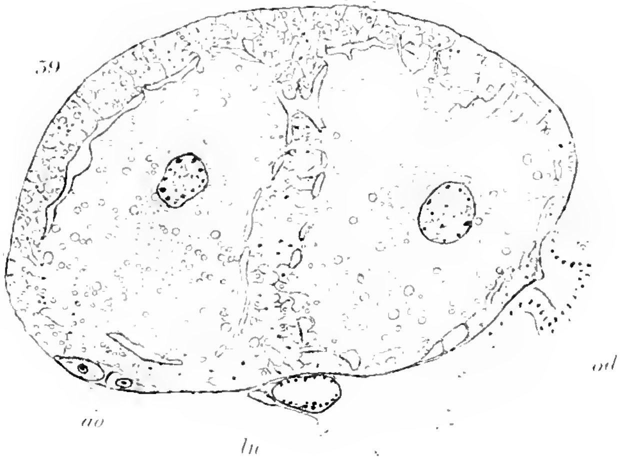
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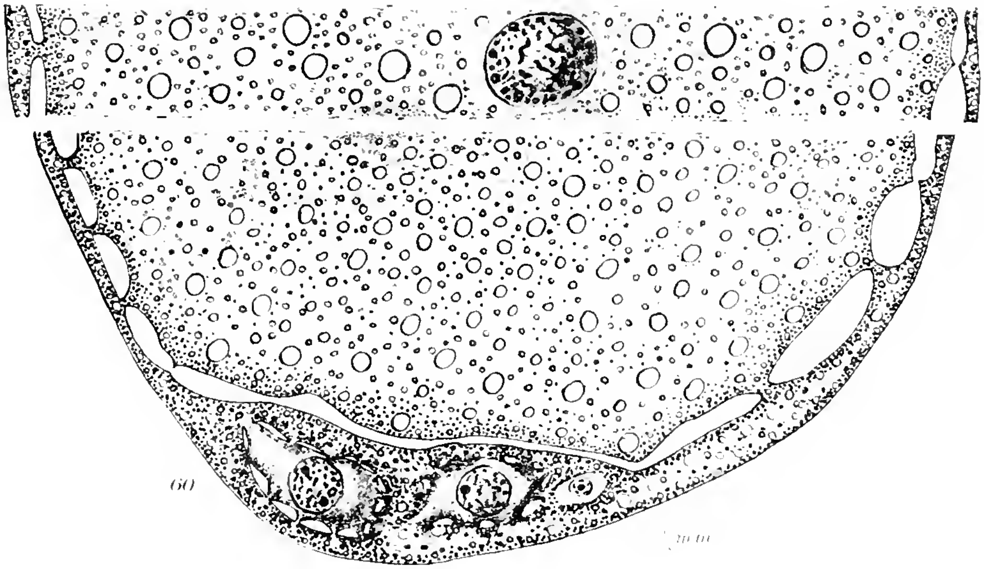
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PLATE 9.

PLATE 9.

Neuronemertes aurantiaca Coe.

Fig. 61. Outline of body of male, showing the ten pairs of spermaries (*sp*) in a single irregular row on each side of the body immediately back of the brain (*br*), together with the general relations of the other organ-systems. The mouth (*m*) is situated on the ventral side of the rhynchodeal opening. The proboscis-sheath (*ps*) extends about three fourths the length of the body, terminating at the point marked *x*. The outlines of the distal portions only of the alimentary canal are shown; *dv*, dorsal blood-vessel, uniting with the lateral vessels just anterior to the posterior nerve-commissure (*nc*); *ic*, intestinal caecum; *id*, intestinal diverticula; *ln*, lateral nerve; *r*, rectum. × 4.

Fig. 62–65. Portions of transverse sections of the proboscis-sheath, showing the relations of the interlacing circular, longitudinal, and spiral muscular fibers of which it is composed; *rc*, epithelium lining rhynchocoel; *py*, pylorus; *par*, parenchyma. × 450.

Fig. 62. From a short distance back of brain; the dorsal vessel (*dv*) still within the rhynchocoel.

Fig. 63. Dorsal vessel passing through the sheath.

Fig. 64. Dorsal vessel imbedded in the parenchyma (*par*) beneath the sheath.

Fig. 65. From the lateral wall of the sheath near the middle of the body. The longitudinal muscular fibers are here grouped in small bundles in the midst of the circular fibers. Peripherally the longitudinal fibers are scattered among the spiral muscles.

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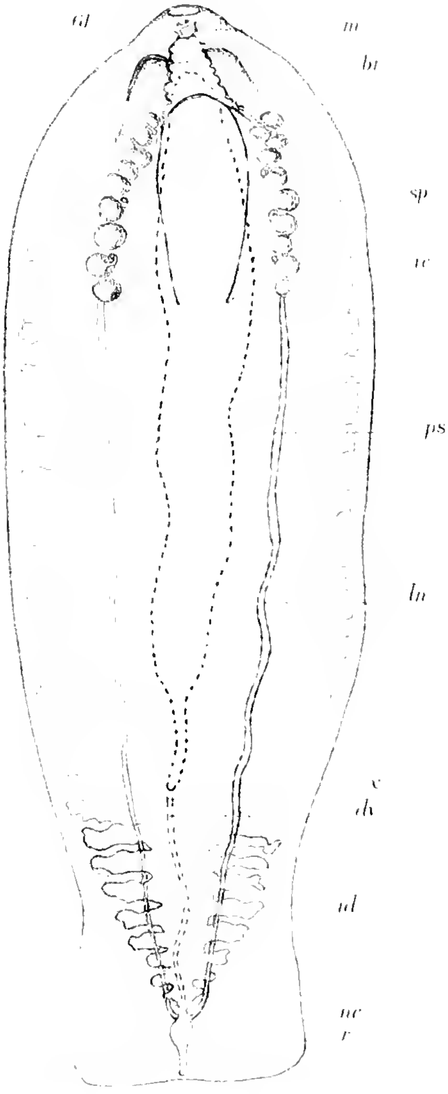

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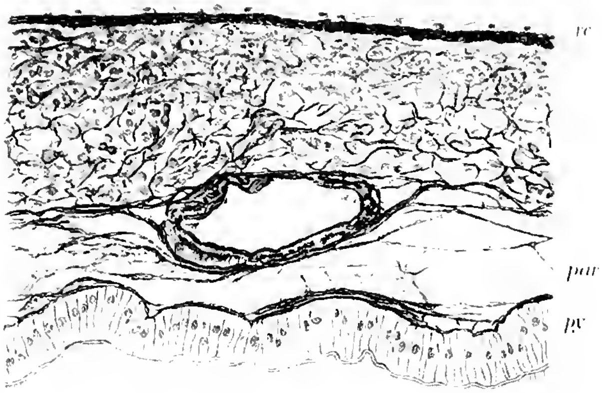

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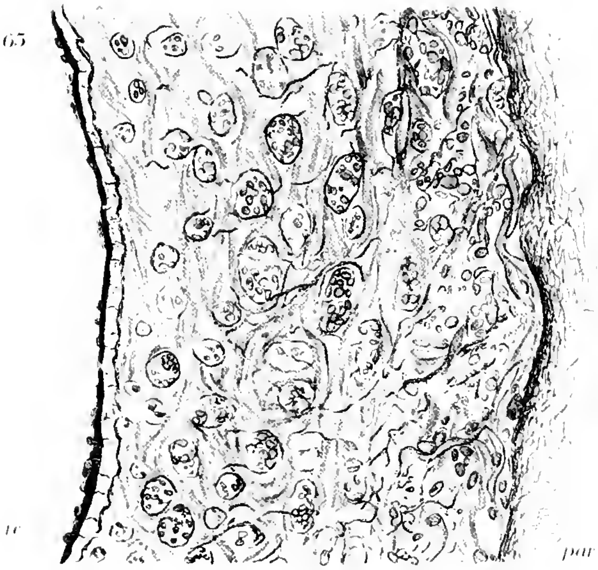

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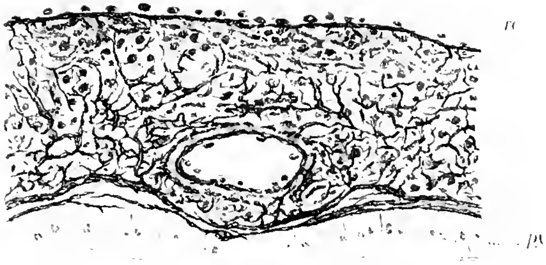

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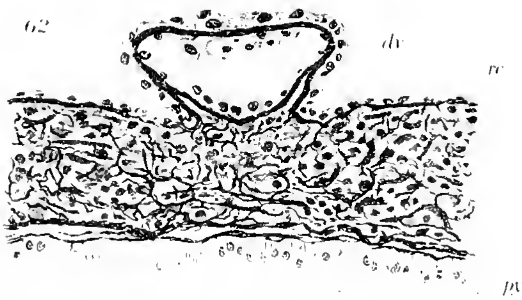

PLATE 10.

PLATE 10.

Neuronemertes aurantiaca Coe.

The various parts of the nervous system are shown in color.

Fig. 66. Transverse section of head in front of brain, showing the numerous cephalic nerves (*n*) and muscle-bundles which traverse the parenchyma in all directions. The radial attachment-muscles (*am*) for the insertion-ring of the proboscis are shown in sections on the dorsal side of the rhynchodeum (*rh*); *bm*, basement-layer with corrugated surface for attachment of integument; *cm*, circular muscular layer; *lm*, longitudinal muscular layer; *bv*, lateral blood-lacuna.

Fig. 67. Transverse section of head, passing through both dorsal (*dc*) and ventral brain-commissures. Numerous nerves and isolated strands of muscles pass obliquely in all directions from the proboscis-insertion immediately in front of brain. Two of the four large muscular bands (*am*, *am'*) which anchor the ring of insertion to the cephalic walls are cut in this section. The basement-membrane (*bm*) is corrugated, with projections for the attachment of the epidermis in life; *bm*, basement-membrane; *cm*, and *lm*, circular and longitudinal muscles of cephalic walls; *bv*, lateral blood-vessel; *rc*, anterior end of rhynchocoel; *st*, stomach. × 50.

Fig. 68. Portion of transverse section of body a short distance back of the brain, showing the spermaries (*sp*) with their ducts (*sd*) leading to the ventral surface. On the right side are shown portions of two adjacent spermaries and the ducts leading from each. The dorsal nerve (*dn*) and the two dorsolateral nerves (*dln*) lie dorsal to the proboscis-sheath. The intestinal caecum (*ic*) lies ventral to the pylorus (*py*), and the branched diverticula of the former are shown above and below the lateral nerves. The strong contraction of the body on preservation makes the organs of the body abnormally crowded together. × 60.

Fig. 69. Small portion of transverse section, showing the intimate union of one of the dorsoventral muscles (*dvm*) with the circular muscles (*cm*) of the body-wall; *n*, accompanying nerve; *np*, nerve-plexus between circular (*cm*) and longitudinal (*lm*) muscles. × 340.

Fig. 70. Section of dorsal blood-vessel within the rhynchocoel, showing the flattened epithelial lining of each and the blood-corpuscles filling the former.

Fig. 71, 72. Longitudinal and transverse sections respectively of spermatic duct, showing its cuboidal, and apparently secretory, epithelium.

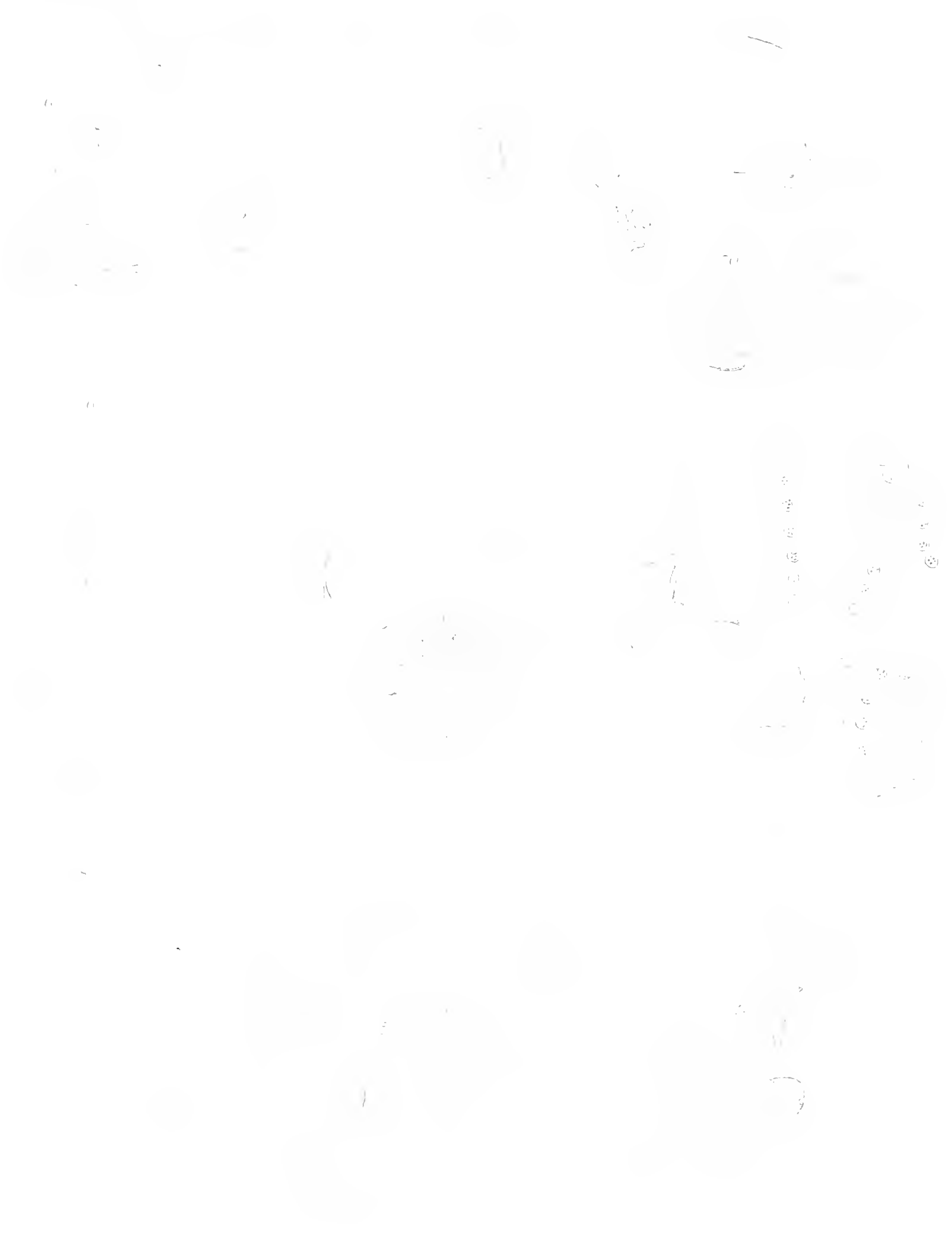

PLATE 11.

PLATE **11**.

Neuronemertes aurantiaca Coe.

Nervous system and problematical organs in color.

Fig. 73–78. Six transverse sections of the dorsal nerve (*dn*) with the problematical organs accompanying it. Figure 73 shows the nerve in section between two adjacent organs. In Figure 74, taken a short distance back of the brain-region, the connection of the nerve with the small organ beneath the circular muscles (*cm*) is shown. In Figure 75, from about one millimeter farther back, a very broad union of nerve and organ is shown, the latter having three ventral lobes. Figure 76 is taken from about the middle of the body, and shows the very large organ (*gl*) beneath the circular muscles (*cm*). Figure 77 is from a nearly adjacent section and shows the broad union of nerve and organ. Figure 78 is from the posterior third of the body. In this section the organ (*gl*) consists of three separate lobes, of which two show the slender connection with the nerve through a narrow opening in the circular muscles (*cm*); *bm*, basement-layer; *lm*, longitudinal muscles; *par*, parenchyma; *np*, intermuscular nerve-plexus; *np′* delicate submuscular nerve-plexus.

Fig. 79. Portion of transverse section somewhat posterior to middle of body, showing the dorsoventral muscles (*dvm*) between proboscis-sheath (*ps*) and intestinal diverticula (*id*); *bm*, basement-membrane; *cm* and *lm*, circular and longitudinal musculatures of body-walls; *dv*, dorsal vessel; *i*, intestine; *id*, diverticulum of same; *ln*, lateral nerve; *lv*, lateral blood-vessel; *par*, parenchyma. × 55

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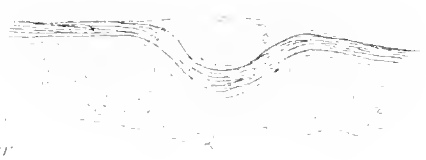

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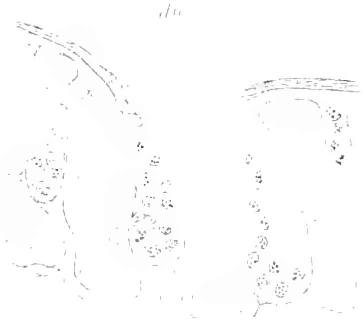

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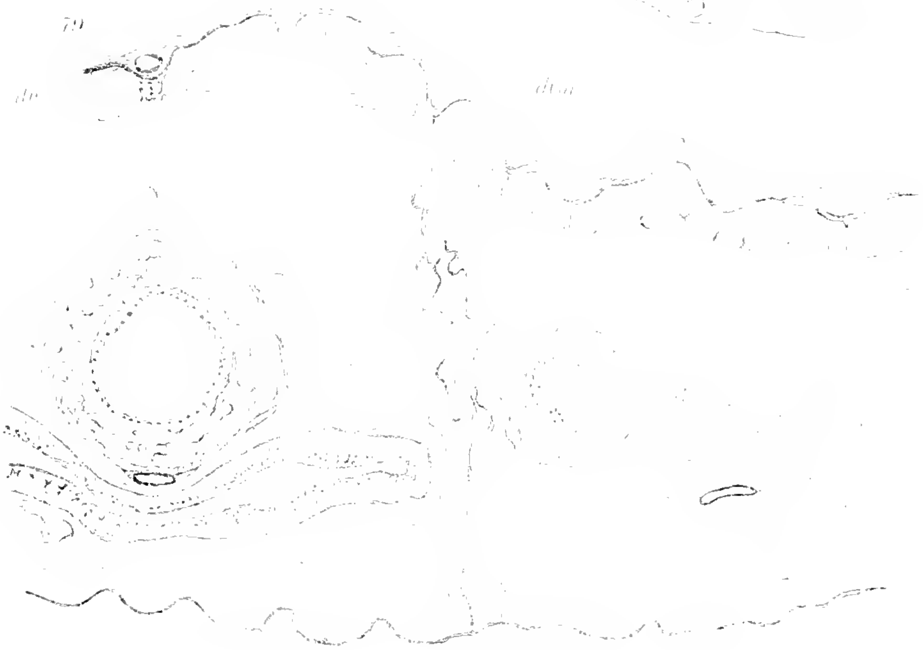

PLATE **12**.

PLATE **12**.

Neuronemertes aurantiaca Coe.

Fig. 80. Portion of transverse section of body a short distance back of brain, showing a spermary (*sp*) with its efferent duct (*sd*), the former closely invested by the dorsoventral musculature (*dvm*); *id*, intestinal diverticula; *lm*, longitudinal muscles of body-wall; *ln*, lateral nerve, *lv*, lateral blood-vessel.

Fig. 81. Small portion of wall of pylorus, showing the regularly placed ciliated and gland-cells. × 170.

Fig. 82. Small portion of transverse section of proboscis-sheath, showing the interlacing muscular fibers.

Fig. 83. Half of transverse section through middle of body, showing the branching of the intestinal diverticula (*id*) both above and below the lateral nerve (*ln*); *bm*, corrugated basement-layer, found only on lateral margin in this region of body; *dn*, dorsal nerve; *dv*, dorsal vessel; *i*, intestine; *ps*, proboscis-sheath. × 40.

Fig. 84. Half of transverse section just anterior to caudal fin, showing the strong dorsoventral muscles (*dvm*) connecting the circular musculature (*cm*) of dorsal and ventral body-walls. × 10.

Fig. 85. Transverse section through caudal fin (*cf*), which is folded back dorsally on one side and ventrally on the other. The narrow rectum (*r*) shows a single small diverticulum (*id*).

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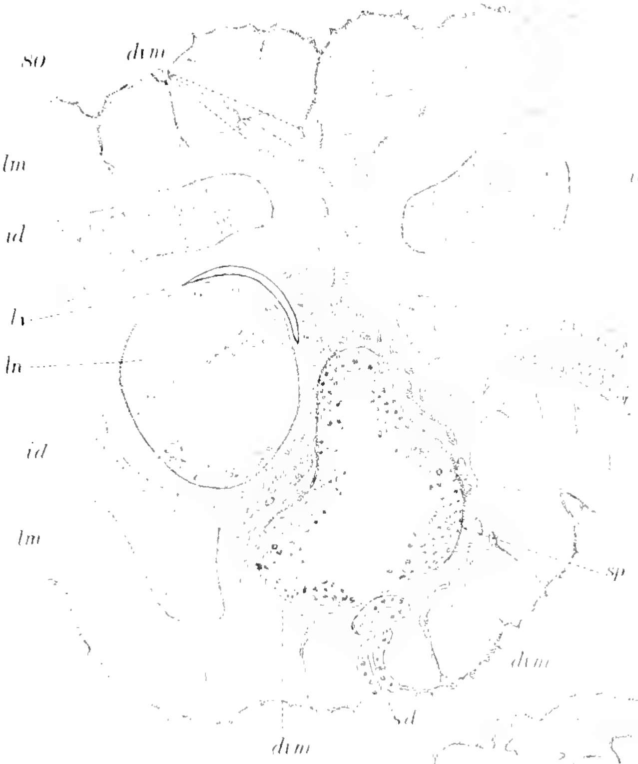

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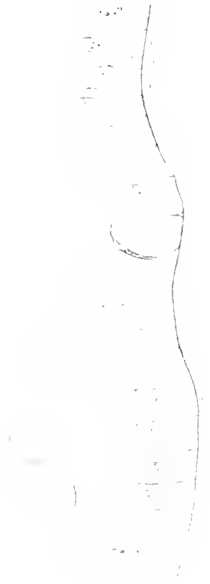

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PLATE **13**.

PLATE **13**.

Fig. 86. Dinonemertes mollis Coe. Outline of body after clearing in oil, showing extent of proboscis-sheath with the much coiled proboscis, and the numerous ovaries, alternating with the slightly lobed intestinal diverticula. × 3.

Fig. 87. Dinonemertes mollis Coe. Outline of body from dorsal surface, showing extent of proboscis and proboscis-sheath, and the intestinal diverticula and ovaries. × 6.

Fig. 88. Planonemertes lobata Coe. Ventral view of mature male, showing the twenty spermaries beside the proboscis-sheath a short distance back of brain, and the form and arrangement of the intestinal diverticula. The median intestinal canal is somewhat wider than the proboscis-sheath, from which the proboscis has been spasmodically extruded. Brain and lateral nerves are also shown. × 7.

Fig. 89. Neuronemertes aurantiaca Coe. Transverse section of lateral nerve-cord, showing the relation of the three peripheral nerves, dorsal (*dp*), lateral (*lp*), and ventral (*vp*), to the fibrous cores of the cord; *lv*, lateral blood-vessel.

Fig. 90. Planktonemertes agassizii Woodworth. Transverse section of lateral nerve-cord, showing the relation of the three peripheral nerves originating from the single fibrous core at each interdiverticular space. Magnification same as in Figure 91.

Fig. 91. Planktonemertes agassizii Woodworth. Transverse section of lateral nerve-cord, showing the single fibrous core with its dorsal (*dcl*) and ventral (*vcl*) layer of nerve-cells; *lv*, lateral blood-vessel. × 240.

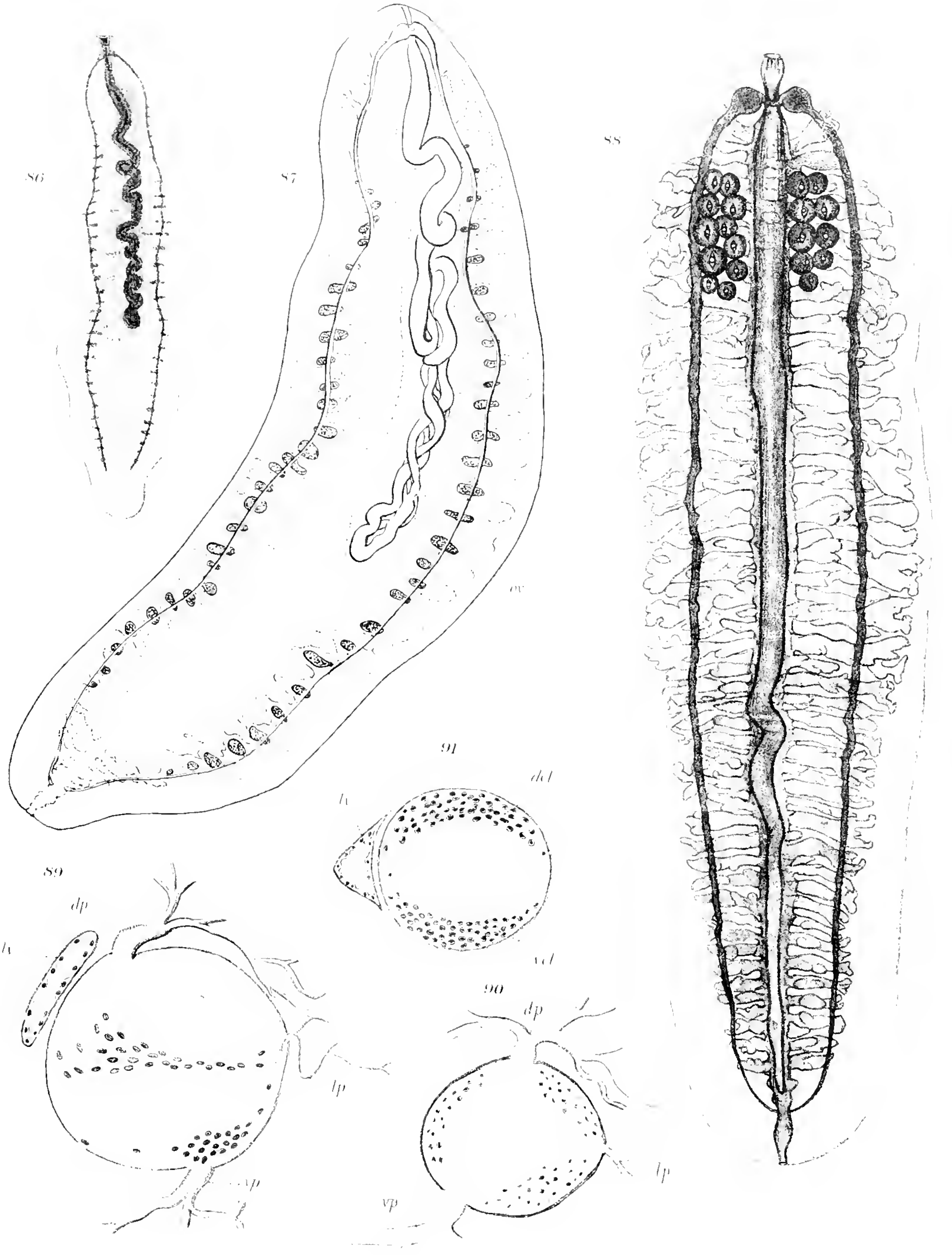
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PLATE **14**.

PLATE **14**.

Planonemertes lobata Coe.

Fig. 92. Portion of transverse section a short distance back of the brain, showing two of the spermaries (*sp*), the pylorus (*py*), intestinal caecum (*ic*) with four lobes (*icd*) of a diverticulum of the latter, and the proboscis-sheath (*ps*), with dorsal vessel in the rhynchocoel. × 45.

Fig. 93. Development of spermatozoa (*spz*) from cytophores of primary and secondary spermatocytes and spermatids; *a*, spermatogonium, which divides repeatedly, the daughter-cells remaining connected in a single mass of cytoplasm, eventually increasing in size to form a cytophore of primary spermatocytes (*b*), of which a single nucleus and its immediately surrounding cytoplasm is shown; *c*, *d*, primary spermatocyte in brachytene and diakinetic stages respectively; *e*, division into two secondary spermatocytes (*f*); *g*, the four resulting spermatids, which transform into spermatozoa as indicated in *h* and *i*.

Fig. 93a. Cytophores of transforming spermatids; *j*, *k*, early and later stages, with radial arrangement about the cytoplasm; *l*, nearly mature spermatozoa in parallel bundle; *m*, a single spermatozoan.

Fig. 94. Horizontal section of three adjacent intestinal diverticula with their tubular distal lobules.

Fig. 95. Portion of transverse section of wall of proboscis-sheath, showing the thick, inner layer of circular muscles (*pcm*) and the very thin outer layer (*pcm'*) with the intervening longitudinal musculature (*plm*); *bm*, basement-layer; *ep*, epithelium lining the rhynchocoel.

Fig. 96. Portion of transverse section of body posterior to spermaries, showing sections of the lateral lobes of an intestinal diverticulum (*id*) in an interdiverticular space; *ln*, lateral nerve, with five peripheral nerves extending toward the body-walls; *lv*, lateral vessel; *dv*, dorsal vessel; *i*, intestine; *ps*, proboscis-sheath; *rc*, rhynchocoel. × 45.

Fig. 97. Portion of transverse section near middle of body, showing the simple nature of an intestinal diverticulum with its rudimentary ventral branch (*vid*); other lettering as in Figure 96. × 45.

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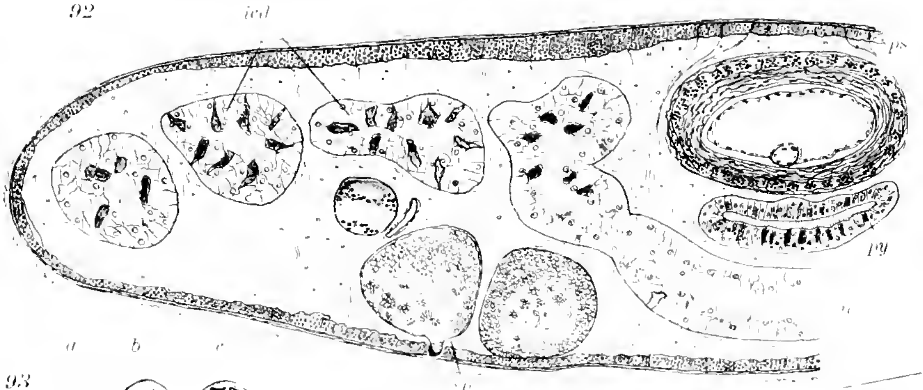

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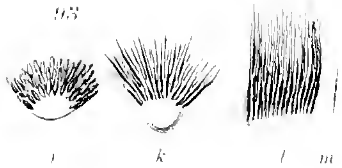

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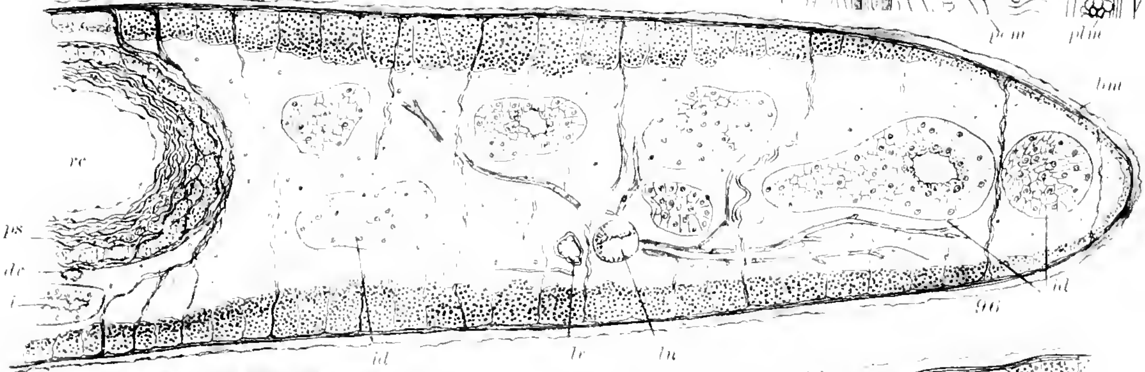

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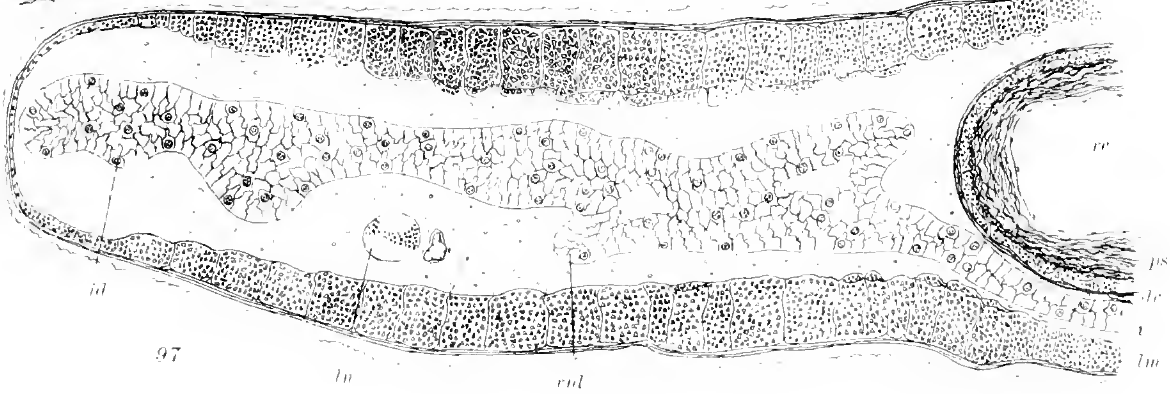

PLATE 15.

PLATE 15.

Plionemertes plana Coe.

Fig. 98. Outline of body from ventral surface, showing the simple character of the numerous intestinal diverticula, each with a short ventral branch. The extremely long proboscis is fully everted. × 10.

Fig. 99. Outline of body from dorsal surface, showing extent of proboscis-sheath and total length of fully everted proboscis. × 10.

Fig. 100. Stylet-basis and stylets.

Fig. 101. Optical cross-section of basis and one of the stylets.

Fig. 102. Section of young ovary, showing the close union of the ova and the peripheral cytoplasm into a common syncytium.

HELIOTYPE CO. BOSTON

PLATE **16.**

PLATE **16**.

Nectonemertes mirabilis Verrill.

Fig. 103. Mature male cleared in cedar-oil after staining with borax-carmine, showing the internal anatomy, with the flattened caudal fin at the posterior end of the body, the horizontal fins, and the tentacles. Anteriorly the specimen shows the cephalic loop (*cv*) of the lateral vessels above the rhynchodeum, the relation of dorsal ganglia (*dg*), lateral nerves (*ln*), the cephalic nerves, and the number and position of the retort-shaped spermaries (*sp*). Near the posterior end of the body is seen the common union of the two lateral blood-vessels (*lv*) and the median vessel (*mv*), and the posterior anastomosis of the lateral nerve-cords (*ln′*) above the intestinal diverticula (*id*). × 8.

Fig. 104. Optical section of portion of proboscis after clearing in oil, showing the stylet-basis, with its wreath of glands (*gl*), the posterior end of the papilliferous anterior chamber, middle chamber (*mc*), with its strong circular muscles, and posterior chamber (*pc*) with thick glandular epithelium.

Fig. 105. Three outlines of stylet-basis, showing free surface with oval depressions for the attachment of the stylets (most of the latter having been dislodged) and the muscular attachments on the roughened inner surface.

Fig. 106. Transverse section of proboscis, showing the twenty proboscidial nerves (*pn*); *cm*, outer circular muscles; *cm′*, inner circular muscles; *ep*, outer epithelium; *ep′*, inner epithelium; *lm*, longitudinal muscles.

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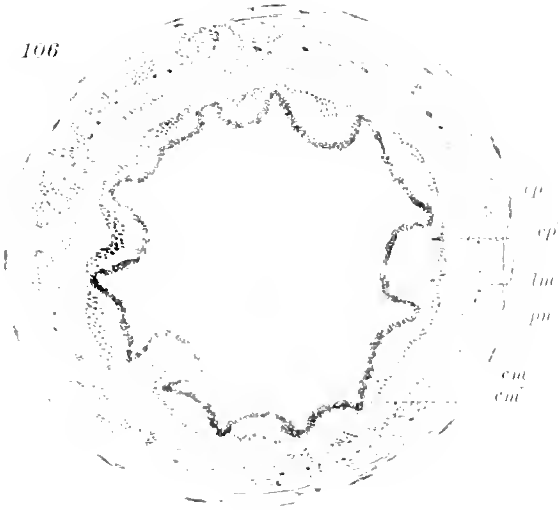

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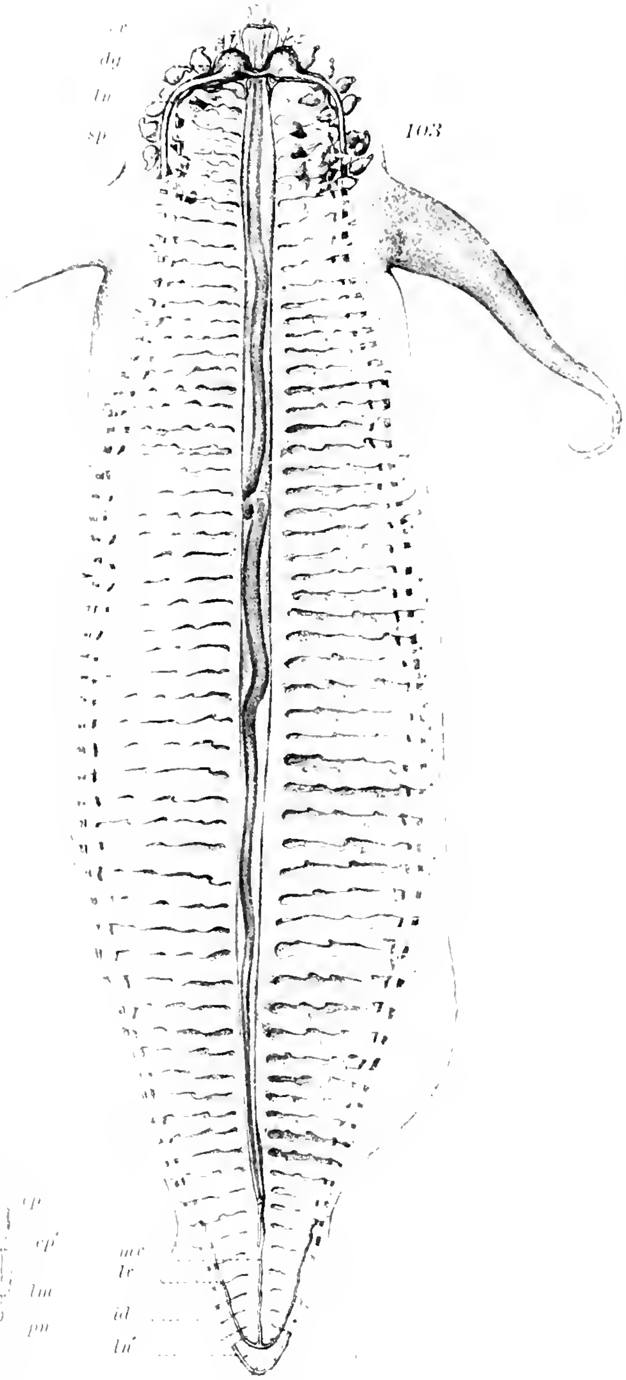


HELIOTYPE CO. BOSTON

PLATE **17**.

PLATE **17**.

Nectonemertes mirabilis Verrill.

Fig. 107. Portion of transverse section of body anterior to tentacles, showing sections of four spermaries (*sp*), cut in different planes. In two of the spermaries the seminal vesicles (*sv*) and spermatic ducts are shown. The spermaries encroach to such an extent on the other tissues as to force the lateral nerve (*ln*) and the diverticula of the intestinal caecum (*icd*) close against the dorsal wall of the body; *lv*, lateral blood-vessel; *par*, parenchyma; *mu*, muscular layer of spermary; *lm*, longitudinal, and *cm*, circular muscular layers of body-wall; *bm*, basement-layer. × 80.

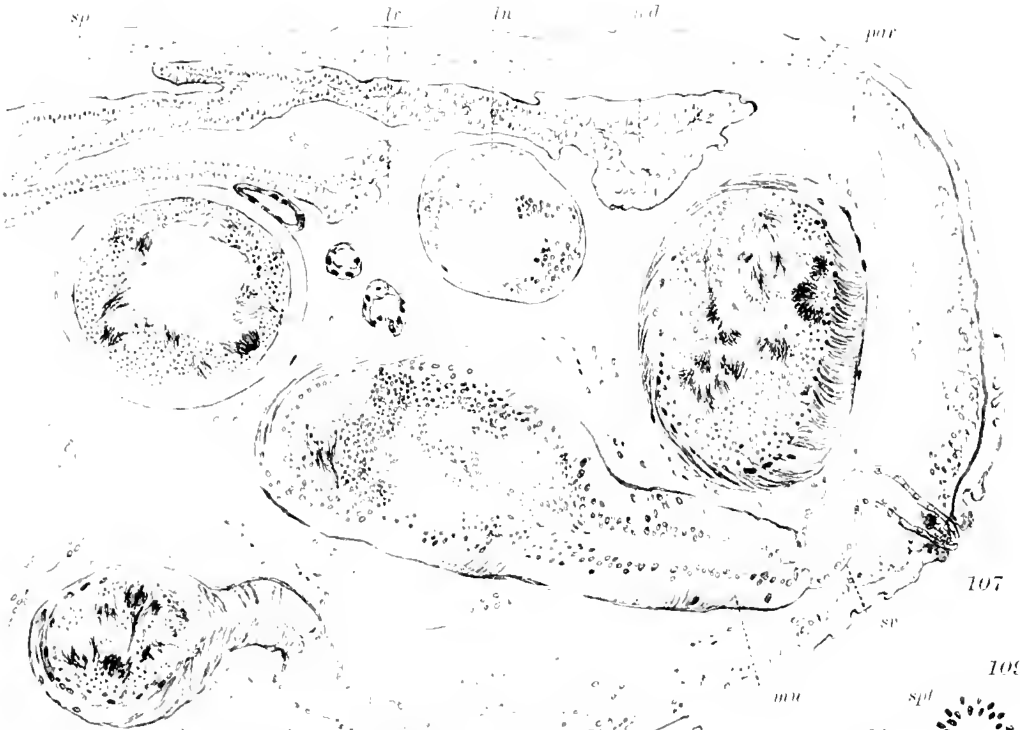
Fig. 108. Transverse section through head of mature male: slightly reconstructed from adjacent sections, showing brain-lobes with dorsal (*dc*) and ventral (*vc*) commissures: stomach (*st*), immediately beneath ventral commissure, and a single lobe (*icd*) of the anterior diverticulum of intestinal caecum. A fully mature spermary (*sp*) is shown, with seminal vesicle leading to ventral surface of head.

Fig. 109. Diagram of spermatogenesis, illustrating the formation of the cytophores of primary spermatocytes (*spc*), secondary spermatocytes (*spc'*), spermatids (*spt*), and spermatozoa.

Fig. 110. Portion of longitudinal section of tentacle, showing its musculature; *cm'*, circular muscular layer; *dvm*, dorsoventral muscles; *ilm'*, inner longitudinal, and *lm'*, outer longitudinal muscular layers. × 200.

Fig. 111. Transverse, or slightly oblique, section of tentacle; lettering as in Figure 110.

Fig. 112. Terminal portion of seminal vesicle and spermatic duct showing mass of mature spermatozoa (*spz*) ready for discharge through genital pore. × 220.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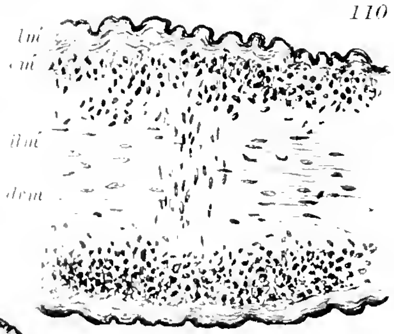
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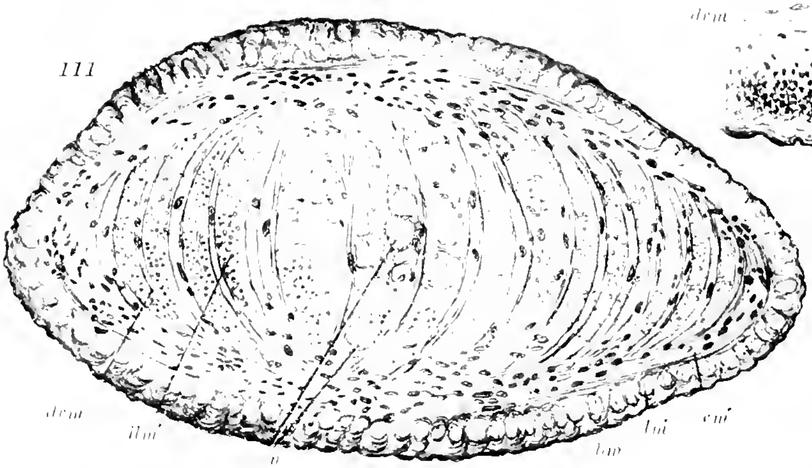
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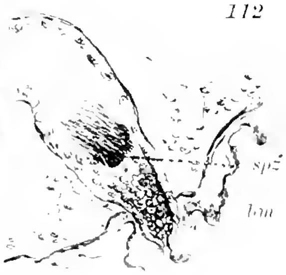
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sp2
bm

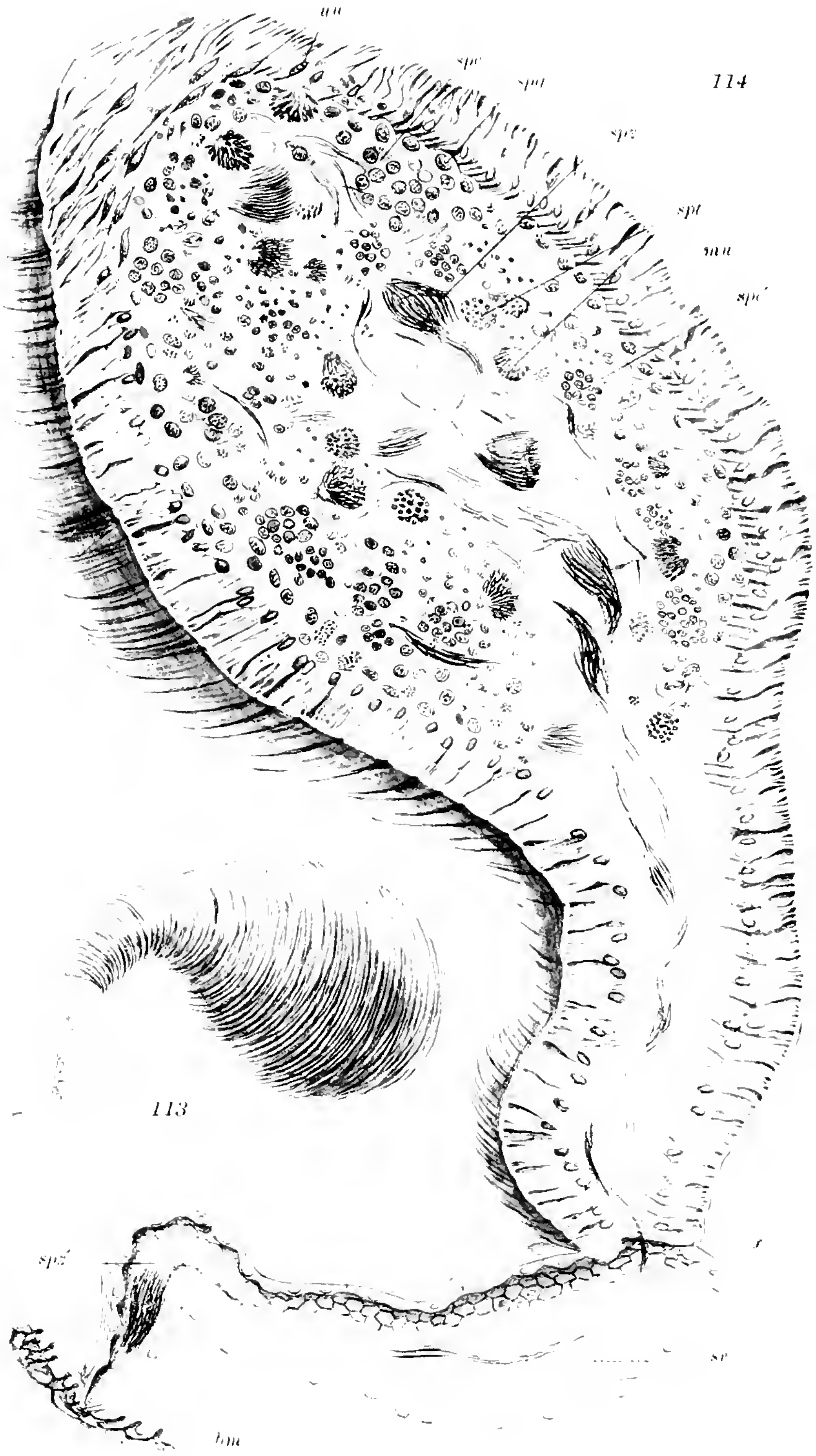
PLATE 18.

PLATE **18.**

Nectonemertes mirabilis Verrill.

Fig. 113. Surface view of a mature spermary, showing the thick layer of spiral muscular fibers surrounding the spermary proper and the epithelial wall of the seminal vesicle, the latter leading to the minute external opening on the ventrolateral border of the head. × 80.

Fig. 114. Optical section of a spermary, with its seminal vesicle and spermatic duct. The thick muscular columns (*mu*) of the spiral musculature surround the germinal cells, which occur in all stages of development; *spg*, spermatogonia; *spc*, primary spermatocytes; *spc'*, secondary spermatocytes; *spt*, spermatids; *spz*, developing spermatozoa collected in bundles from the cytophores; *x*, opening from spermary into the seminal vesicle (*sv*) with its thin epithelial wall; *spz'*, mass of mature spermatozoa ready to be discharged through the spermatic duct which opens to the exterior by a minute pore in the basement-membrane (*bm*) of the body-wall; *nu*, nuclei of muscle-fibers. × 280. (Compare Plate **17**, fig. 109).



HELIOTYPE CO. BOSTON

PLATE 19.

PLATE 19.

Fig. 115. Nectonemertes mirabilis Verrill. Transverse section through middle of body, showing proboscis (*p*) in its sheath (*ps*) and the extensive development of the intestinal diverticula (*id*); *cm*, circular muscular layer; *lm*, longitudinal muscular layer; *ln*, lateral nerve; *lv*, lateral blood-vessel; *rc*, rhynchocoel. × 140.

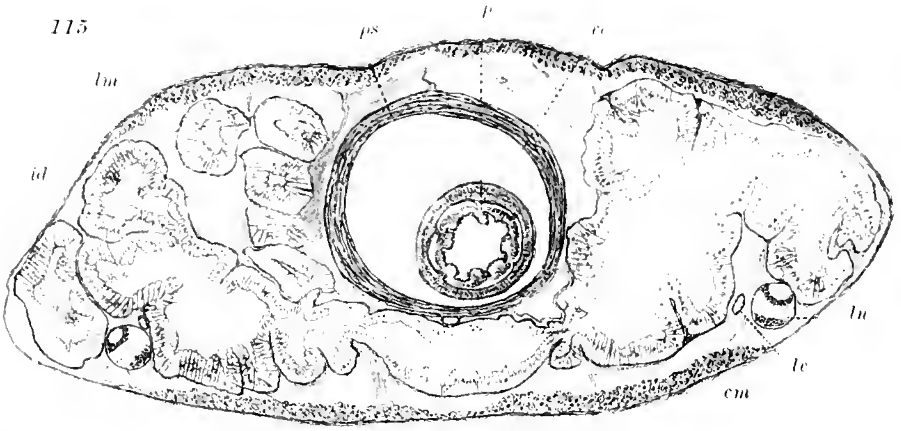
Fig. 116. Nectonemertes mirabilis Verrill. Half of transverse section through caudal fin, showing posterior commissure of lateral nerves (*ln'*) between and above intestinal diverticula (*id*) and the series of dorsoventral muscle-bundles between dorsal and ventral body-walls. × 65.

Fig. 117. Nectonemertes mirabilis Verrill. Portion of transverse section through posterior extremity of body, showing extreme development of dorsoventral muscles in the caudal fin, with their nuclei lying midway between the two ends of the fibers; *r*, rectum. × 65.

Fig. 118. Nectonemertes pelagica Cravens & Heath. Outline of body of female, showing position of proboscis, proboscis-sheath, and ovaries. × 8.

Fig. 119. Nectonemertes pelagica Cravens & Heath. Nearly mature ovary, showing the definitive ovum with numerous lobed pseudopodia joining the nucleated peripheral vitellogenous cytoplasm, with several abortive ova at the proximal end of the oviduct (*od*).

115



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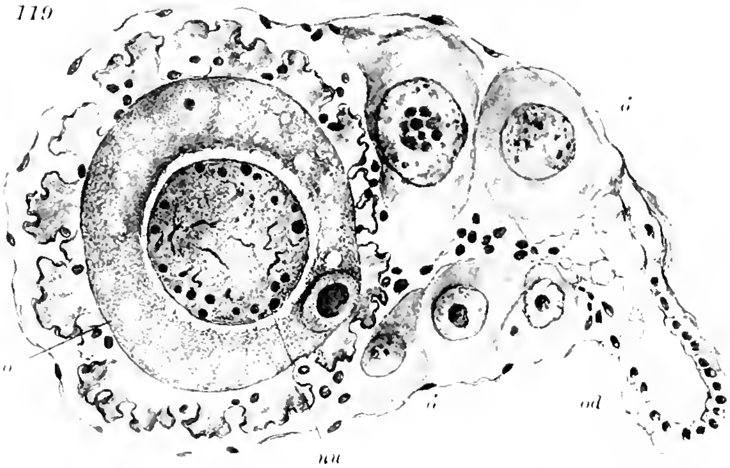

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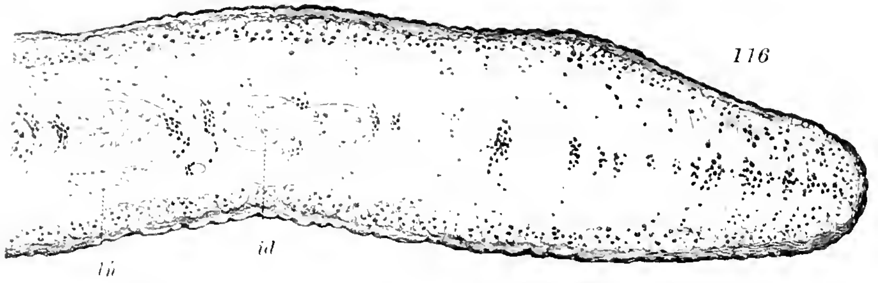

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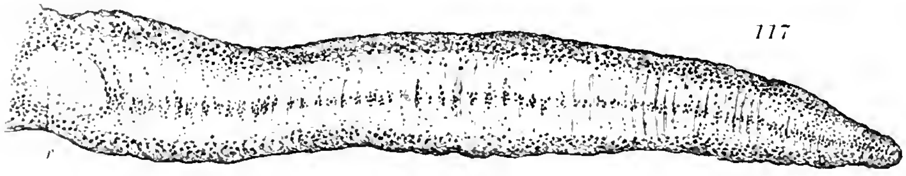


HELIOTYPE CO. BOSTON

PLATE 20.

PLATE **20**.

Proarmaueria pellucida Coe.

Fig. 120. Outline of cleared preparation of specimen A from dorsal surface, showing dorsal opening of rhynchodeum with proboscis partially everted, the short, ovoid proboscis-sheath, the branched intestinal diverticula and the distal row of eight gonads. Posterior to the proboscis-opening are shown the dorsal ganglia connected by the narrow commissure. × 9.

Fig. 121. Outline of body showing in somewhat diagrammatic manner the vascular system and gonads. The ventral cephalic anastomosis (*va*) is distended to form a broad lacuna, a similar enlargement of the vessels occurring at the posterior anastomosis (*pa*); from the latter a caudal vessel extends to posterior extremity. The hermaphroditic gonads are distinguished from the spermaries by circles representing the contained ova; *m*, mouth; *ro*, rhynchodeal opening.

Fig. 122. Somewhat diagrammatic lateral view of body, showing the dorsal curvature of the cephalic region with dorsal rhynchodeal opening (*ro*) and terminal mouth (*m*). The distal row of gonads is indicated, with circles to distinguish the hermaphroditic glands from the spermaries. At * is indicated the position of the large hermaphroditic gland which occurred in specimen B. The positions of proboscis-sheath, brain, and lateral nerve are also shown.

Fig. 123. Transformation of primary spermatocytes into a cytophore of spermatids.

Fig. 124. Spermary with cytophores. Sperm-duct extends only as far as the basement-membrane of the body-wall.

HELIOTYPE CO. BOSTON

PLATE **21**.

PLATE **21**.

Proarmaueria pellucida Coe.

Fig. 125. Optical section of portion of proboscis of specimen B, showing middle chamber (*mc*) with stylet-basis, together with portions of anterior (*ac*) and posterior (*pc*) chambers.

Fig. 126. Stylet-basis of same specimen, with a single row of small, conical stylets on its free border.

Fig. 127. Portion of longitudinal section of proboscis of specimen A, in which the stylet-basis appears crescentic in section.

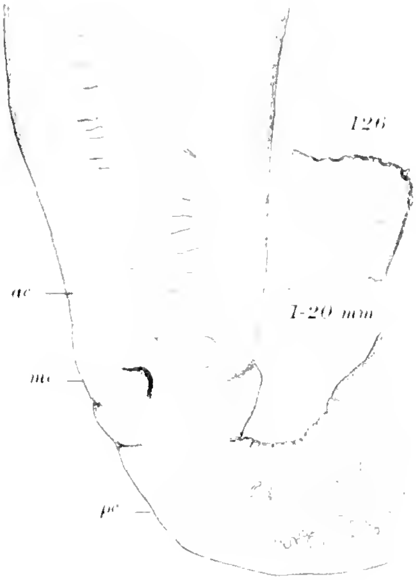
Fig. 128. Transverse section of proboscis of specimen B, showing the seven large nerves alternating with an equal number of smaller ones. The epithelium lining the lumen has been dislodged.

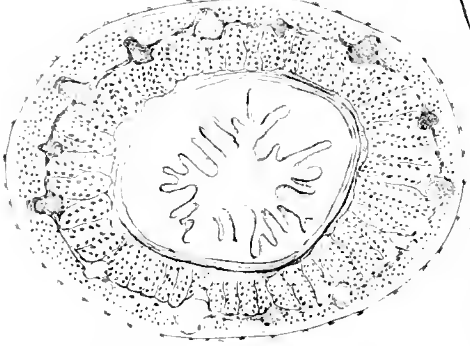
Fig. 129. Section of head nearly transverse to body-axis, but very oblique to rhynchodeal opening (*rh*), showing the thick insertion-ring (*pi*) of proboscis *p*, the latter being partly everted. Above the pylorus (*pyl*) is the large ventral blood-lacuna (*bl*) and below it the broad caecum (*c*), the latter with voluminous lobulated diverticula (*cd*). Two sections of the lateral nerve (*ln*, *ln'*) on one side of the body result from the dorsal curvature of the head; *dg*, dorsal ganglion; *sd*, spermatic duct; *sp*, spermary; *pn*, proboscis-nerve.

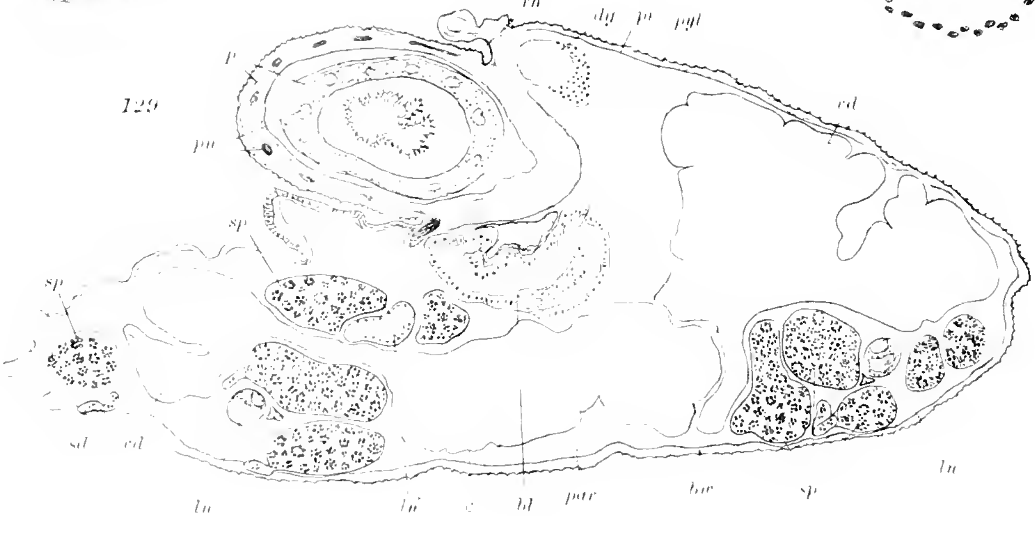
Fig. 130. Papillae of proboscis, with rhabdites crowded in distal portions of the slender epithelial cells.

Fig. 131. Transverse section of nerve-cord near middle of body, showing the slender dorsal fibrous core.

Fig. 132. Transverse section of nerve-cord in anterior portion of body, showing the smaller dorsal fibrous core separated by a layer of nerve-cells from the larger ventral core.







HELIOTYPE CO. BOSTON

PLATE **22**.

PLATE **22**.

Proarmaueria pellucida Coe.

Fig. 133. Portion of section of head cut nearly transversely to main axis of body (but on account of dorsal curvature, nearly parallel with lateral nerves in this region), showing rhynchodeal opening (*ro*), proboscis-insertion (*pi*), oblique section of proboscis (*p*), three spermaries (*sp*), two sperm-ducts (*sd*), the lateral (*lv*) and dorsal vessel (*dv*), pylorus (*pyl*), and ventral ganglion (*vg*).

Fig. 134. Portion of transverse section through caudal fin showing caudal nerve (*cn*) branching from posterior end of lateral nerve (*ln*), a portion of the posterior nerve-commissure (*pnc*) above the rectum (*r*) and the proximal end of the widely distended caudal vessel (*cvd*).

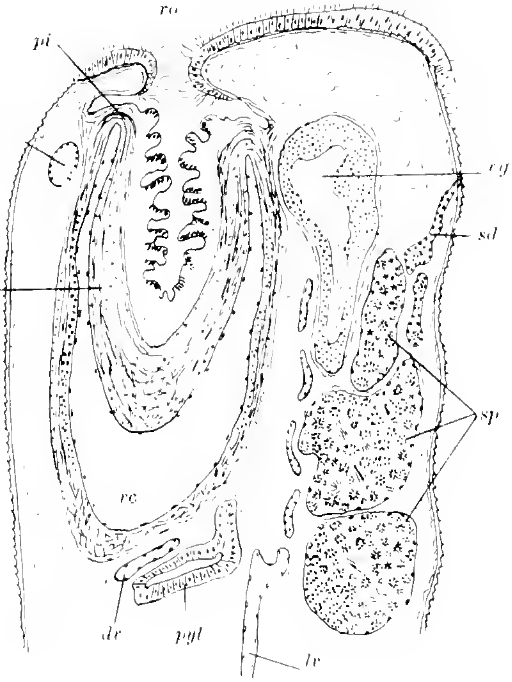
Fig. 135. Portion of transverse section through posterior end of caudal region, showing the caudal nerve (*cn*) beside the rectum (*r*) and the distended caudal blood-vessel (*cvd*).

Fig. 136. Section of hermaphroditic gland with four large ova (*o*) and a few spermatocytes (*spc*).

Fig. 137. Very small gonad, showing the large oval nucleus of the single ovum (*o*), the protoplasm of which is continuous with that of the syncytium of undifferentiated cells lining the entire inner wall of the gonad,

Fig. 138. Section of large hermaphroditic gland, showing portions of nine ova and several cytophores of spermatocytes.

133



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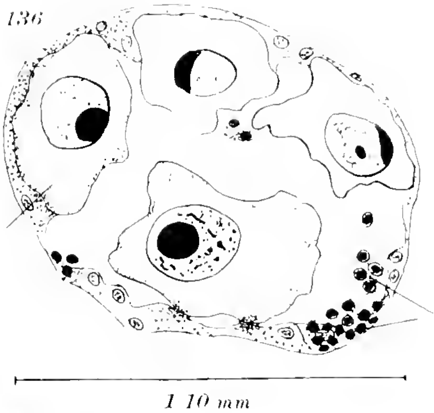

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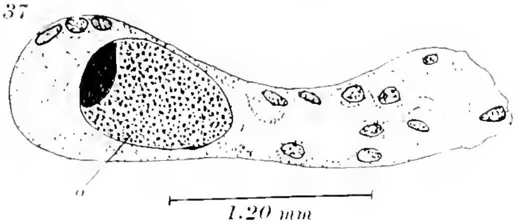

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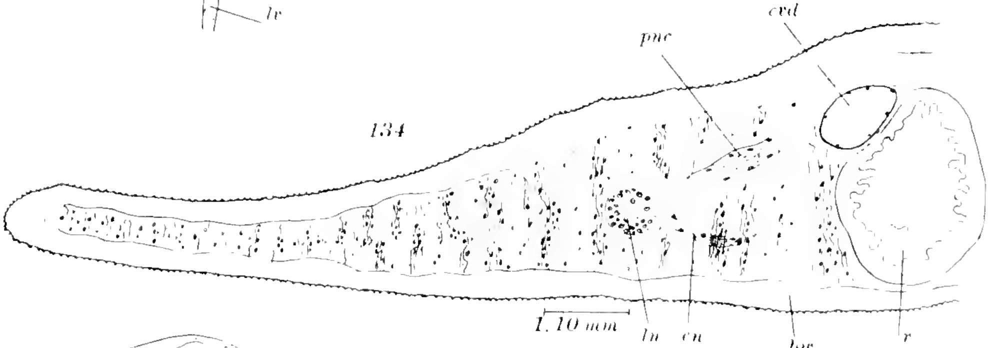

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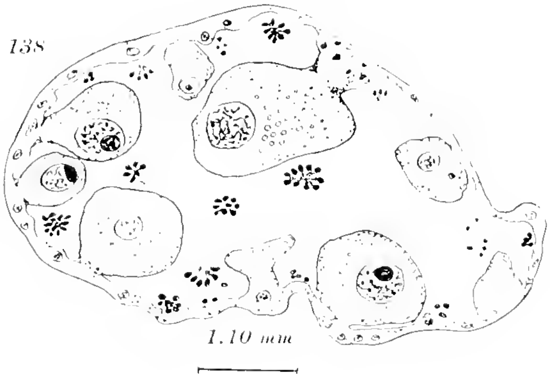

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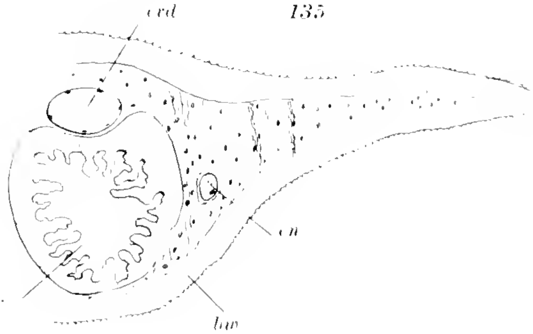

HELIOTYPE CO BOSTON

PLATE **23**.

PLATE 23.

Proarmaueria pellucida Coe.

Fig. 139. Portion of hermaphroditic gland, showing four ova closely connected with a thin peripheral vitellogenous syncytium and several cytophores of spermatocytes.

Fig. 140. Portion of another section of the same gonad, showing six large and several small, abortive ova, with their syncytial connections, and numerous cytophores of spermatocytes.

Fig. 141. A small hermaphroditic gland with two ova and many spermatocytes, some of the latter having been forced (by pressure during capture?) into the genital duct (*gd*) which extends to the inner border of the body-wall (*bw*).

Fig. 142. A small hermaphroditic gland with a single ovum and few spermatocytes.

Fig. 143. A small hermaphroditic gland with one large ovum imbedded in a thick mass of peripheral cytoplasm (*syn*) and one small ovum (*ao*) as well as large cytophores of spermatocytes.


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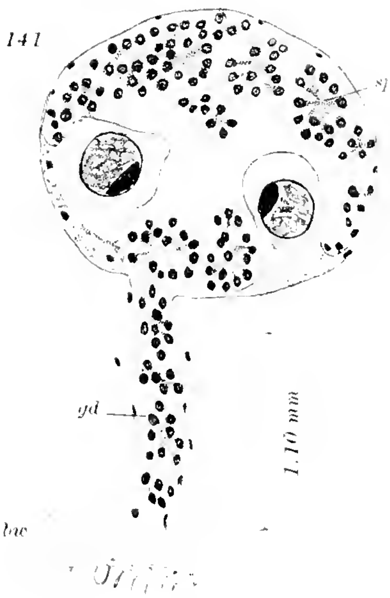
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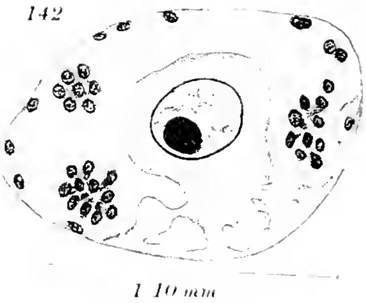
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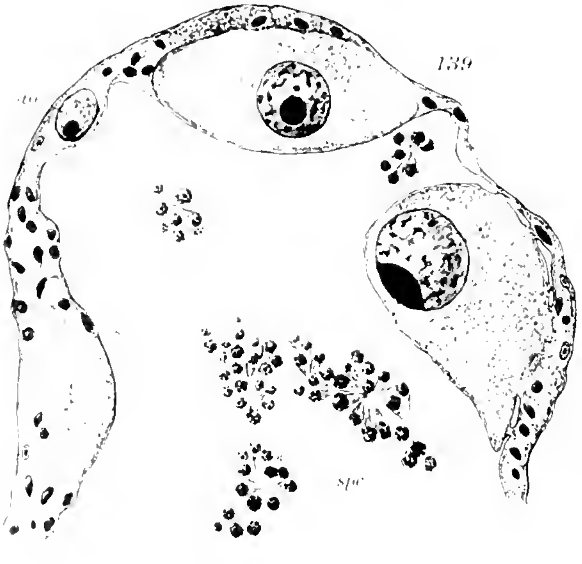
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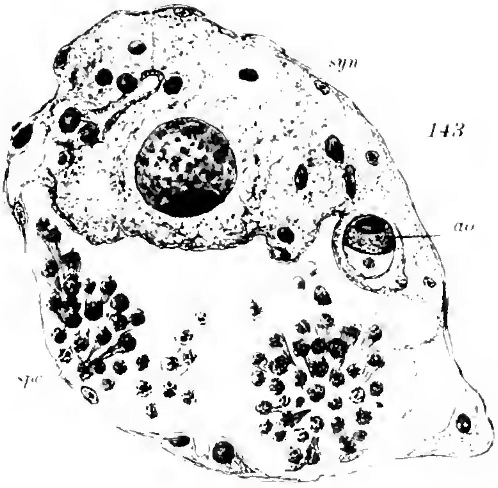
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HELIOTYPE CO. BOSTON

PLATE **24**.

PLATE **24**.

Cuneonemertes gracilis Coe.

Fig. 144. Outline of body from dorsal surface, showing position of ovaries alternating with the profusely branched intestinal diverticula, the everted proboscis, with stylet at tip and with the retractor attached to the wall of the widely distended proboscis-sheath. × 20.

Fig. 145. Transverse section through brain-region, immediately posterior to the proboscis-insertion, showing the relatively large size of both dorsal (*dg*) and ventral ganglia (*vg*), the correspondingly large commissures, sections of some of the large cephalic nerves (*n*), the stomach (*st*), and the greatly distended rhynchocoel (*rc*) surrounding a section of the slender posterior chamber of the proboscis.

Fig. 146. Transverse section through the everted proboscis showing section of both anterior and posterior chambers with the position of the constituent layers reversed; *rc'*, extension of rhynchocoel separating the two sections; *bm*, inner basement-layer, the inner rhabdite-bearing epithelium having been entirely dislodged; *bm'*, intermuscular plexus; *ocm*, *ocm'*, outer circular muscles of anterior and posterior chambers respectively; *icm*, inner circular musculature; *lm*, longitudinal muscles, the inner and outer portions of which are separated by the nerve-plexus joining the twelve large nerves (*n*).

Fig. 147. Transverse section through posterior third of body, showing on one side an intestinal diverticulum (*id*) with the lobes of the dorsal branch and the short ventral branch; on the left-hand side the section passes through an interdiverticular space, cutting three lateral lobes (*id*) of the adjacent diverticulum; *ps*, proboscis-sheath; *ln*, lateral nerve with nerve-cord muscle; *lv*, lateral vessel.

Fig. 148. Transverse section of lateral nerve, showing the extent of the nerve-cord muscle (*ncm*) along the median dorsal border.

Fig. 149. Section of young ovary, with the follicular syncytium in process of differentiation into primitive ova and follicular cells.

Fig. 150. Nearly mature ovary, with the single large ovum filled with yolk-granules and attached by numerous protoplasmic processes to the follicular syncytium. Several abortive ova (*ao*) are situated at the base of the partially formed oviduct.

Fig. 151. Ovary from which the ovum has been recently discharged, the follicular syncytium being partially disintegrated, but the abortive ova remain apparently unchanged.

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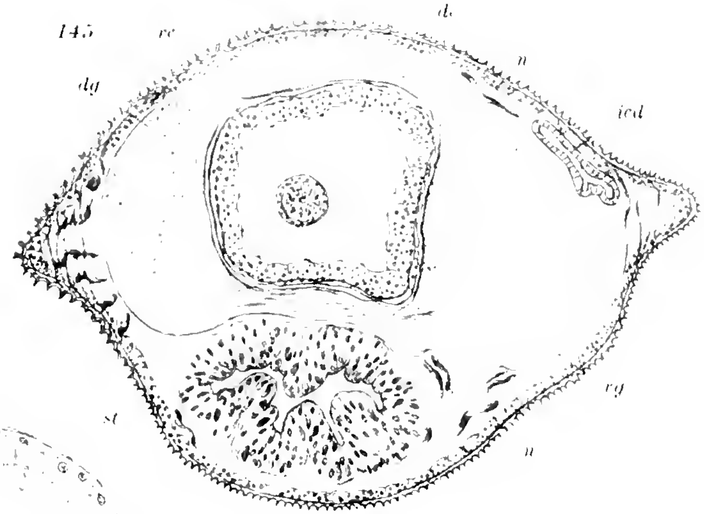

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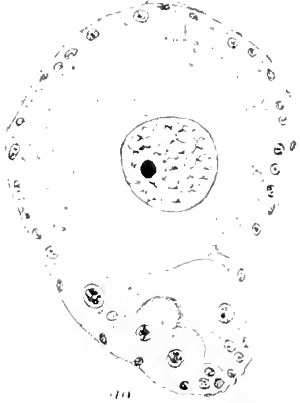

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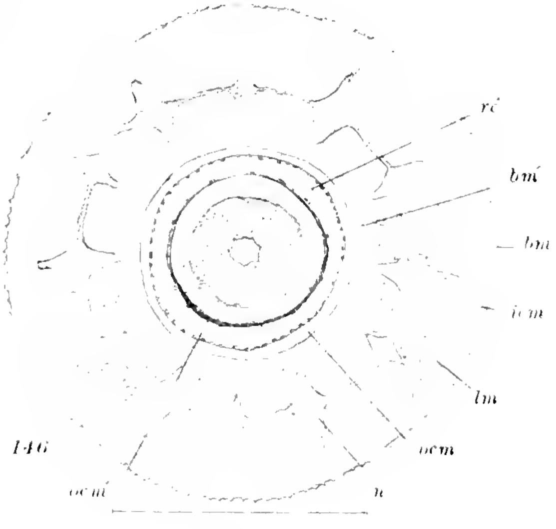

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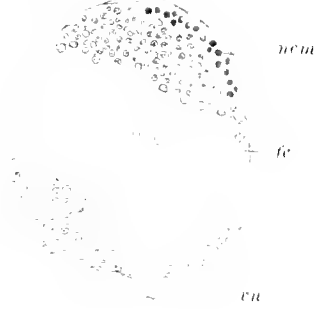

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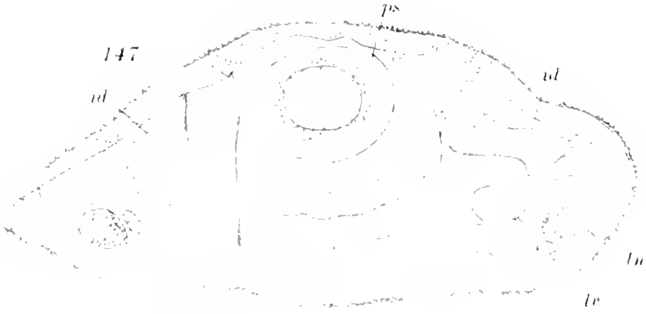

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HELIOTYPE BOSTON

PLATE 25.

PLATE 25.

Pelagonemertes joubini Coe.

Fig. 152. Section of ovary, showing five rather large ova, each surrounded by a thin layer of follicle-cells and attached distally by protoplasmic processes to the vitellogenous syncytium lining the wall of the ovary; *ao*, abortive and undeveloped ova.

Fig. 153. Outline of body of type specimen after clearing in oil, showing the extent of the everted proboscis, the voluminous proboscis-sheath (*ps*), mouth (*m*), intestinal caecum (*ic*), intestinal diverticula, lateral nerves, and the immature ovaries (*ov*).

Fig. 154. Small portion of transverse section of wall of proboscis-sheath, showing the arrangement of the musculature; *ep*, epithelium lining rhynchocoel; *lm*, longitudinal muscles; *cm*, inner layer of spiral fibers; *cm'*, outer layer of spiral fibers.

Fig. 155. Half of transverse section through anterior third of body, showing the relatively simple intestinal diverticulum (*id*) and the muscular layers of the proboscis-sheath.

Fig. 156. Transverse section (somewhat reconstructed) through head, showing brain (*br*), with dorsal and ventral commissures (*dc* and *vc*), stomach (*st*), intestinal diverticulum (*id*), proboscis (*p*), and the position of the horizontal bands of longitudinal muscles (*mu*, *mu'*) which anchor the rhynchodeum to the body-walls; *i*, integument; *cm* and *lm*, circular and longitudinal muscles of body-walls; *n*, one of the numerous cephalic nerves; *ps*, proboscis-sheath.

Fig. 157. Outline of middle chamber and adjacent portions of anterior and posterior chamber of proboscis, showing position of basis and glandular wreath.

Fig. 158. Outline of basis, showing position of the eight stylets.

Fig. 159. Optical sections of basis and stylets.

Fig. 160. Integumentary cells from head, showing ciliated cells and two types of unicellular glands.

Fig. 161. Transverse section of lateral nerve, showing the two portions of the nerve-cord muscle (*ncm* and *ncm'*), the former entering the dorsomedian border of the nerve-cord while the latter enters on the ventral side; *vpn*, origin of a ventral peripheral nerve.

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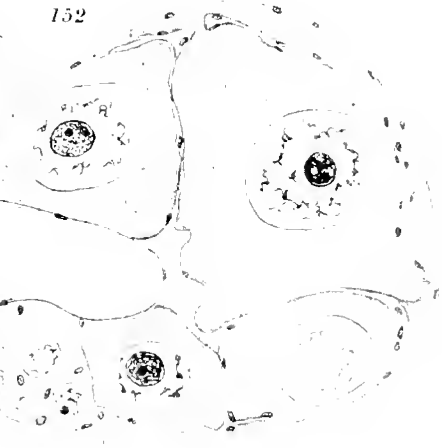

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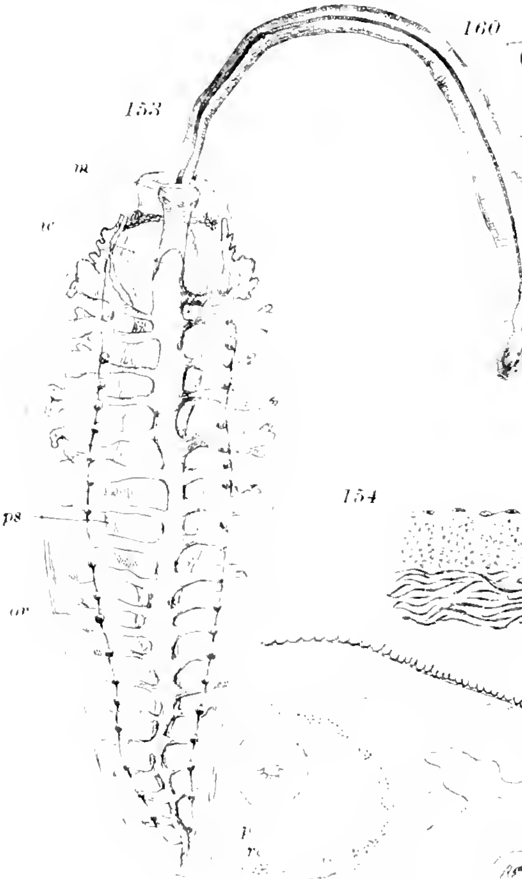

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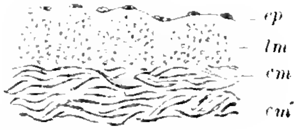

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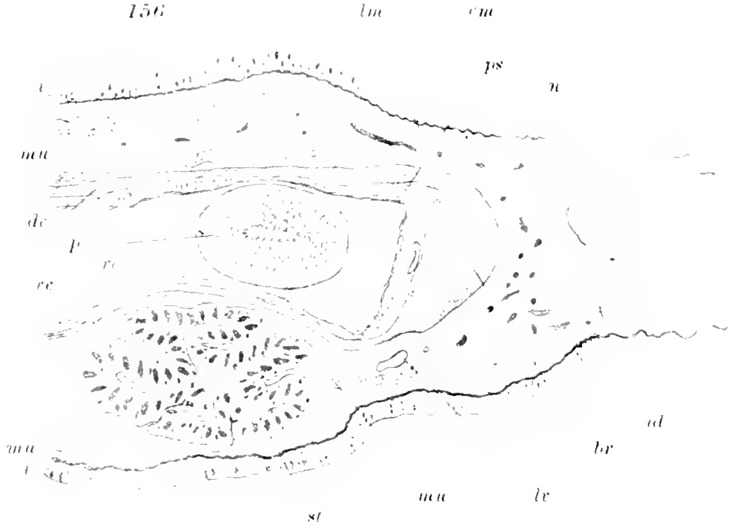

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PLATE 26.

PLATE 26.

Pelagonemertes brinkmanni Coe.

Fig. 162. Ventral view of a much contracted female with half-grown ova. The specimen is peculiar in having nine intestinal diverticula on one side of the body instead of the usual four or five.

Fig. 163. Ventral view of a small and much contracted male with very unsymmetrical intestinal diverticula. The minute spermaries are shown beside the brain.

Fig. 164. Ventral view of anterior end of body of mature male, showing the position of the egg-shaped spermaries (*sp*) in two different states of contraction of the body; *id*, intestinal diverticulum; *st*, stomach; *ic*, intestinal caecum; *py*, pylorus; *ps*, proboscis-sheath; *br*, brain; *m*, mouth; *ln*, lateral nerve; *lv*, lateral blood-vessel.

Fig. 165. A similar view of a male in which the spermaries have been forced outside the anterior border of the head by the rupture of the cephalic tissues either during capture or as a result of the action of the killing fluid. In front of the brain are shown two of the muscular bundles (proboscis attachment-muscles) which anchor the posterior end of the rhynchodeum to the cephalic musculature.

Fig. 166. Reconstruction from sections of a single spermary, showing the spiral musculature. The distal portion is strongly contracted, forcing the developing germ-cells into the rounded middle portion. The musculature is seen to end at the commencement of the efferent duct (*gd*).

Fig. 2

Fig. 3

Fig. 1

Fig. 5

PLATE **27**.

PLATE **27**.

Pelagonemertes brinkmanni Coe.

Fig. 167. Cleared preparation of proboscis, showing armature. The sickle-shaped basis with its minute conical stylets is surrounded by upwards of a dozen pouches of accessory stylets. The glandular wreath is omitted for the sake of clearness; *ac* and *pc*, anterior and posterior proboscis-chambers.

Fig. 168. Outline of stylet-apparatus of a cleared preparation of the proboscis, showing the stylet-basis and the pouches of accessory stylets, the latter projected onto a single plane.

Fig. 169. Optical longitudinal section of middle chamber (*mc*) of proboscis and adjacent portions of anterior (*ac*) and posterior chambers (*pc*), showing the deeply stained sickle-shaped basis and the underlying glandular wreath (*gl*). Two of the pouches of accessory stylets are indicated.

Fig. 170. Basis, showing the free border bearing seven stylets; *mu*, radiating muscles from terminal portion of basis; *mu'*, dense musculature in which basal portion of basis is imbedded.

Fig. 171. Several accessory stylets, showing variations in form and size.

Fig. 172. Sagittal section of head, showing two of the lateral proboscis attachment-muscles (*am'*, ventrolateral, and *am'''*, dorsolateral) continuous with those of the everted proboscis (*pm*); *bm'*, thick basement-layer of proboscis, from which the epithelium lining the lumen has been dislodged; *bl*, cephalic blood-vessels; *rh*, rhynchodeum. Proboscis about half-way everted.

Fig. 173. Section similar to the preceding but nearer the median line, showing two of the median proboscis-attachment muscles (*am*, median ventral, and *am''*, median dorsal), the origin and insertion of the nerve-cord muscle (*ncm*), the origin and insertion of one of the stomach-muscles (*sm*) and their relation to the proboscis-insertion (*pi*); *bm*, basement-membrane; *lv*, lateral blood-vessel; *ln*, lateral nerve; *py*, position occupied by pylorus in adjacent sections; *rh*, rhynchodeum.


167
m
168
172
bl
ch
bm
pm
pm
bm
bm
171
169
170
173
pl
ch
ps
pm
bm

PLATE 28.

PLATE 28.

Fig. 174. Pelagonemertes brinkmanni Coe. Small portion of section through the posterior proboscis-chamber, showing the slender columnar gland-cells, closely packed with globules of secretion; *pcm*, circular musculature; *plm*, longitudinal musculature; *pep*, outer, flattened epithelium of proboscis-wall.

Fig. 175. Pelagonemertes brinkmanni Coe. Portion of transverse section of body through the anterior portion of the pyloric region, showing the dorsal vessel in the rhynchocoel (*rc*), the dorsal nerve (*dn*), and the great mass of gelatinous tissue separating viscera from body-walls; *py*, pylorus; *ic*, intestinal caecum; *bm*, basement-layer; *n*, nerve.

Fig. 175a. Pelagonemertes brinkmanni Coe. Epithelial cells from the anterior portion of the pylorus, showing the slender ciliated cells with a few interspersed gland-cells.

Fig. 176. Pelagonemertes brinkmanni Coe. Portion of transverse section of body, showing an ovary with three half-grown ova and two small, degenerating ones. The oviduct opens on the ventral surface of the body beside the small ova.

Fig. 176a. Pelagonemertes brinkmanni Coe. More highly magnified section of same ovary as shown in Figure 176. The cytoplasm and yolk-material of the eggs are seen to be united at intervals by pseudopodial connections (*x*) with a peripheral layer, representing the fused remains of the degenerated primitive ova (*ao*) and the yolk-forming follicle-cells.

Fig. 177. Pelagonemertes brinkmanni Coe. Portion of section of an hermaphroditic gonad, showing five of the seven amoeboid ova which this gonad contained. Each ovum is provided with an incomplete follicular layer of cells quite distinct from the smaller cells lining the wall of the gonad. The numerous spermatocytes are closely crowded together in the remaining portion of the lumen.

Fig. 177a. Pelagonemertes brinkmanni Coe. Three primary spermatocytes, *a*, *b*, and *c*, showing respectively, leptotene and brachytene nucleus and prophase of mitosis.

Fig. 178. Planktonemertes agassizii Woodworth. Portion of longitudinal section of the proboscis-sheath, showing the interlacing musculature; *ep*, epithelium lining the rhynchocoel; *bm*, basement-layer; *cm*, inner circular muscles; *cm'*, outer circular and spiral muscles; *lm*, longitudinal muscles; *par*, parenchyma.

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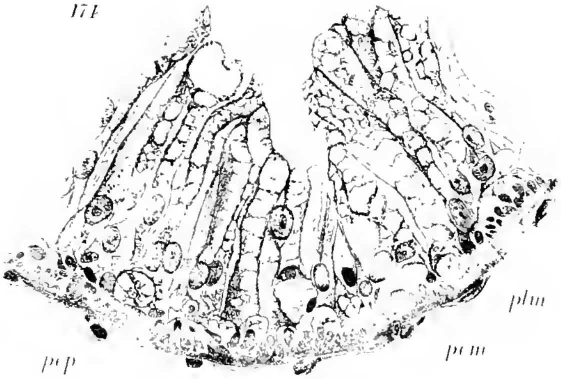

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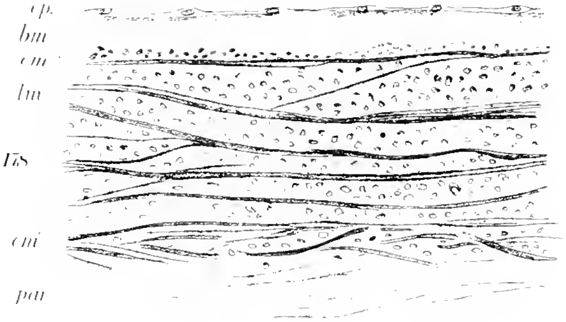

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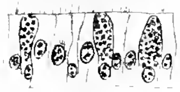

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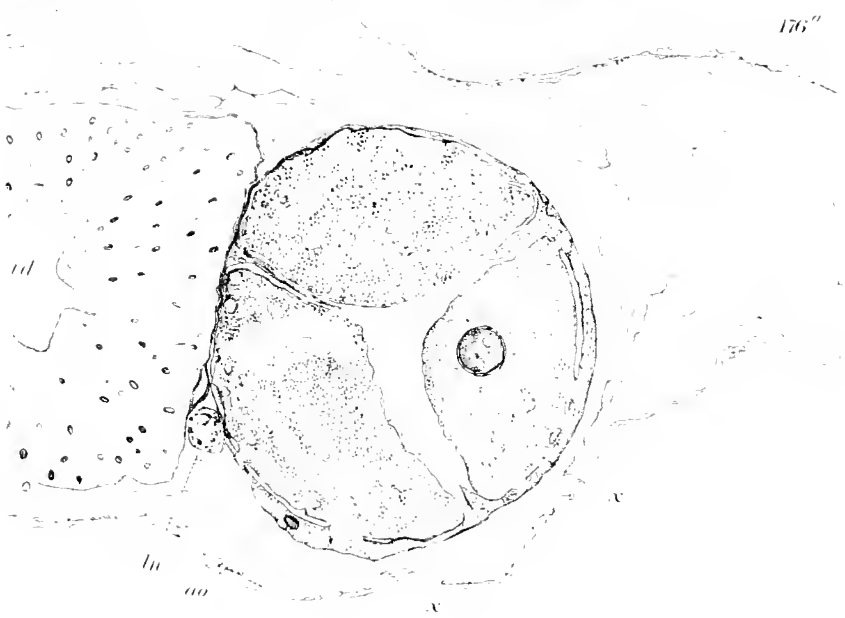

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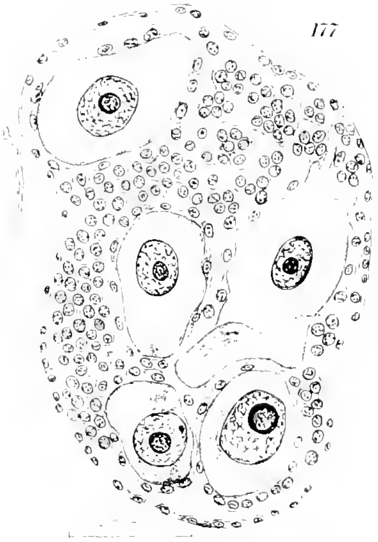

PLATE **29**.

PLATE 29.

Pelagonemertes brinkmanni Coe.

Fig. 179–188. A series of transverse sections through head, body, and caudal regions, drawn at the same magnification to show the relations of the internal organs. The intestine and its diverticula are shown in yellow and the blood-vessels in red.

Fig. 179. Near the anterior border of the head, showing the radially disposed proboscis-attachment muscles (*am*, *am'*, *am''* and *am'''*) which pass from the ring of insertion of the proboscis to the muscular wall of the head. In this section the median dorsal attachment-muscles (*am''*) are most conspicuous.

Fig. 180. Just anterior to proboscis-attachment, showing dorsal blood-vessel anastomosis, ventrolateral attachment-muscles (*am'*) passing obliquely ventrally to their attachment to the cephalic wall on either side posterior to the mouth (*m*). The dorsal cephalic anastomosis of the blood-vessels lies on the dorsal side of the rhynchodeum (*rh*).

Fig. 181. Through brain-region, showing both dorsal and ventral brain-commissures; the median ventral proboscis-attachmentm uscles (*am*) are attached to ventral body-wall on either side of the stomach (*st*). The cephalic vessels lie on the median border of the ventral ganglia (*vg*).

Fig. 182. At posterior end of ventral brain-commissure, showing the ventral blood-vessel anastomosis and origin of lateral vessels (*lv*); *py*, pylorus.

Fig. 183. Posterior to brain-region, showing proboscis in sheath, with dorsal blood-vessel; *py*, pylorus; *ic*, intestinal caecum.

Fig. 184. Posterior to pyloric region, showing relatively large size of proboscis and rhynchocoel (*rc*).

Fig. 185. Near posterior end of proboscis-sheath.

Fig. 186. At base of caudal fin; dorsoventral muscles highly developed.

Fig. 187. Through caudal fin, showing dorsal nerve-commissure (*nc*).

Fig. 188. Section posterior to that shown in Figure 187 with posterior blood-vessel anastomosis (*bva*) above the rectum (*r*).

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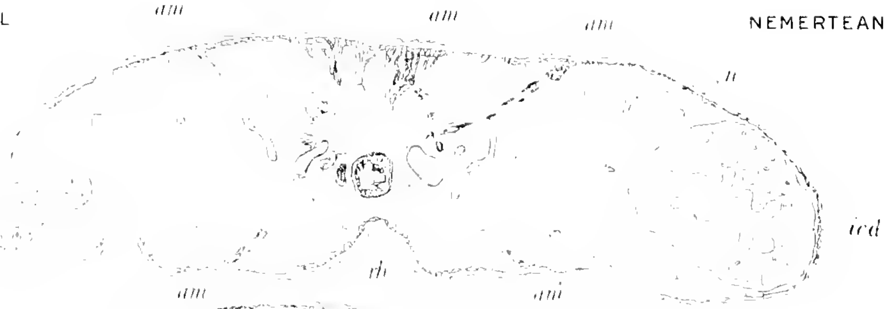

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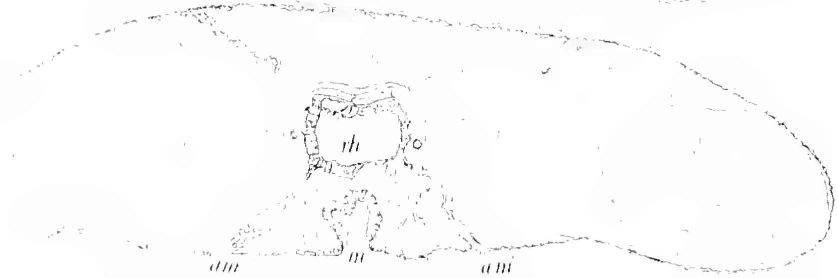

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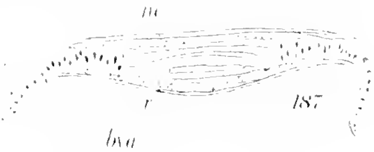

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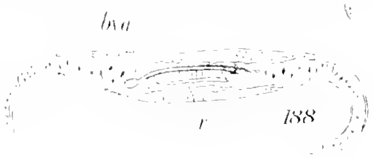

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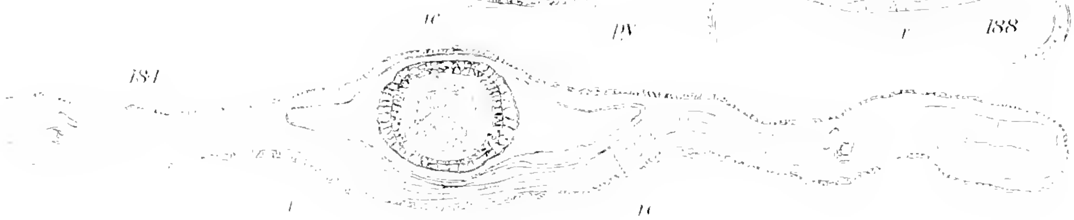

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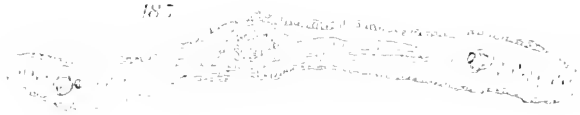

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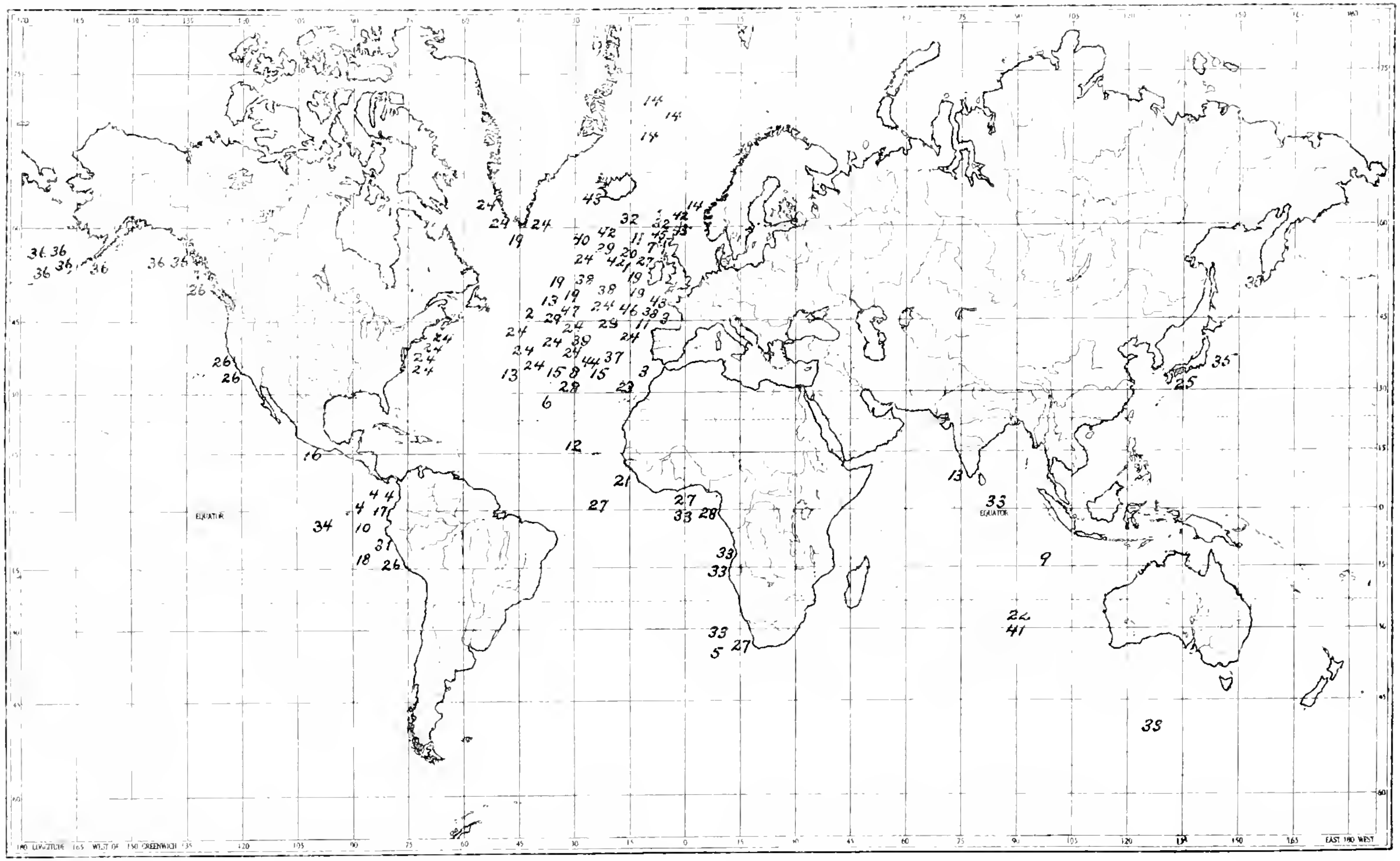
PLATE 30.

PLATE 30.

Chart showing the distribution of the species of bathypelagic nemerteans recorded at the present time. The numbers represent the species number as given in the systematic description of genera and species and as more fully explained in the chapter on geographical distribution.

Twenty-eight species are as yet known from a single locality only. Where two or more stations for the same species are near together only one is indicated. In the case of 36, Pelagonemertes brinkmanni, two of the stations indicated for the Bering Sea should have been shown east of Kamchatka.

For permission to use Goode's base map the author is indebted to the University of Chicago Press.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180 LONGITUDE 165 WEST OF 150 GREENWICH 135
EAST 180 WEST

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